Vol. 8 MARCH, 1925 No. 3

Journal

of the

American Ceramic Society

Abstracts Bulletin

A Monthly *Journal* Devoted to the Arts and Sciences Related to the Silicate Industries

CONTENTS

Original Papers:

Limestone for Sheet Glass Making—Arthur 125
Dynamic Symmetry as Applied to Pottery—Richter 131
The Course in Pottery at the Pennsylvania Museum School of Industrial Art—Curtis 138
Further Experiments in the Problem of the Turquoise Alkaline Glaze—French 143
Observations on Pinholing in Cast Ware—Hemphill 145
Some Forms of Sulphuring on Earthenware Glazes—Shegog 148
Designing Bands for Round Kiln Crowns—Wilson 154
A Modern Brick Plant—Robson 159
The Making of Dolomite Brick and A Study of Their Properties.—II—Andrews, Bole and Withrow 171

Ceramic Abstracts 51

The Bulletin:

Editorials 89
Activities of the Society 126
Notes and News 144

Advertisers' Index 19

"AMERICA'S LEADING CERAMIC MATERIAL HOUSE"

FELDSPAR N.C.

"Dependable—Uniform—Not a Corduroy Spar"

YOU KNOW THE
FACTS
BUT HAVE YOU MADE
A TRIAL
?

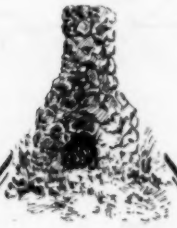
THE MERITS AND FINE POINTS OF THIS BODY & GLAZE SPAR ARE WORTH YOUR EFFORTS IN MAKING A WORKING TRIAL UNDER ACTUAL MANUFACTURING CONDITIONS TO APPRECIATE ITS VALUE.

YOUR TRIAL ORDER SOLICITED

THE
ROESSLER & HASSLACHER
CHEMICAL CO.
NEW YORK

Chicago	Trenton	New Orleans
Philadelphia	Cleveland	Boston
Pittsburgh	San Francisco	Kansas City
	Baltimore	

(When writing to advertisers, please mention the JOURNAL)



Write For These Bulletins

Distribution of Kaolin and Bauxite of the Coastal Plain of Georgia.

Directory of Commercial Minerals in Georgia and Alabama along Central of Georgia Railway.

Washing Tests of Georgia Clays.

Georgia Clays for Paper Fillers.

Georgia Clays for Rubber Fillers.

Use of Sedimentary Kaolins of Georgia in Whitewares.

Kaolin and Refractory Clay Deposits in Wilkinson Co., Ga.

Utilization of Georgia Kaolins in the manufacture of Face Brick.

Refractory Possibilities of Some Georgia Clays.

"Chimney Rock"

Makes high grade Refractories

When the early settlers in Central Georgia needed material with which to construct their chimneys, they went out and dug up a gray buff rock, which, because of the use to which it was put, became known as "Chimney Rock." This rock was sufficiently soft so that it could be quarried and cut readily, but when exposed it hardened.

Aside from the fact that this material made admirable chimneys, the early settlers probably knew or cared little else about this "Chimney Rock." Only within recent years has the material found its rightful niche in the industrial world. Today "Chimney Rock," now known as Bauxite Clay, is being more and more widely used.

The Bauxitic Clays are those with a silica-alumina ratio of 1.8 to 0.8. They are apparently a mixture of clay and bauxite. These clays vary in color and hardness from snow white and very soft to the gray buff rock. The deformation temperatures of the bauxitic clays are cones 35–38. They are found abundantly over large areas throughout the Coastal Plain of Georgia and Alabama associated with Kaolins and Bauxites. Their distribution, ease of mining and refractory properties make the bauxitic clays ideal materials for the manufacture of high grade refractories.

An unusually interesting booklet telling about the formation and distribution of bauxitic clays and other refractory clays in Georgia is available. The Industrial Department of the Central of Georgia Railway will gladly send a copy without cost to those interested.

Central of Georgia Railway

J. M. Mallory
Gen'l Industrial Agent

CENTRAL GEORGIA

233 West Broad St.
Savannah, Ga.

HF&G

HF&G TIN OXIDE

THE HARSHAW FULLER AND GOODWIN CO.

Cleveland

Chicago New York Philadelphia

JOURNAL
OF THE
AMERICAN CERAMIC SOCIETY

A monthly Journal devoted to the arts and sciences related to the silicate industries.

Publication Office: 211 Church St., Easton, Pa.
Editorial and Advertising Offices: Lord Hall, O. S. U., Columbus, Ohio.
Committee on Publications: F. K. PENCE, Chairman; A. W. KIMES, F. H. RHEAD, W. E. DORNBACH, ROSS C. PURDY.
Editor: ROSS C. PURDY; **Assistant Editor:** EMILY C. VAN SCHOICK; **Associate Editors:** L. E BARRINGER, E. W. TILLOTSON, ROY HORNING, R. R. DANIELSON, A. F. GREAVES-WALKER, F. H RHEAD, H. RIES, R. L. CLARE.

Entered as second-class matter July 15, 1918, at the Post Office at Easton, Pa. under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 16, 1918.

(Copyright 1925, American Ceramic Society)

Twelve dollars a year — Single numbers, one dollar
(Foreign postage, 50 cents additional)

Vol. 8 **March, 1925** **No. 3**

ORIGINAL PAPERS

LIMESTONE FOR SHEET GLASS MAKING[1]

BY EDWIN P. ARTHUR

ABSTRACT

Quarry selection is suggested as a more rational basis for the specification of a limestone for making sheet glass than limits of chemical composition. Non-representative sampling is recommended in testing limestone for contamination.

The proper quality of lime and limestone for glass making has been the subject of some discussion[2] but sufficient emphasis has perhaps not been placed on the requirements of a limestone for sheet glass and window glass manufacture. Sheet glass, including all glass drawn from the molten melt,[3] must be of the very highest quality to meet the present demands of the market.[4] With the exception of optical glass and some specialties, it seems probable that drawn sheet glass requires higher quality raw materials and more careful process control than any other glass. This is true not only because of the large unit sizes of the ware[5] and the purposes for which sheet glass is used, but also because of the peculiar nature of the process of

[1] Recd. Jan. 21, 1925. Presented at the Annual Meeting of the AMERICAN CERAMIC SOCIETY, Columbus, Ohio, Feb., 1925. (Glass Division.)

[2] Turner, English, and others, *Jour. Soc. Glass Tech.* U. S. Bur. Stand., *Bull.* **118,** "Tentative Specification of Limestone for Glass Making," Peddle, "Glass," **1,** 148 (1924), and many others.

[3] The latest methods of making plate glass involve a drawing operation.

[4] "Master Specification of Glass for Glazing," U. S. Bur. Stand., *Circ.* **164.**

[5] A sheet of window glass 40″ x 60″ weighs about 26 pounds.

manufacture. The "drawing operation" very materially exaggerates the size of any seeds or stones in the glass and makes more conspicuous any slight defects in the body of the glass. Maintaining the color of a flint glass tank subject to heavy load requires a similar careful control of furnace conditions and temperatures.[1]

Of the raw materials used for sheet glass making, limestone is most subject to variation.[2] The alkali furnished to the trade is manufactured under strict technical control. The preparation of glass sand is a well-developed industry. Limestone, on the other hand, is largely supplied from stone quarries where the main production centers on furnace flux, building material or burned lime rather than a special product for the glass trade.

Limestone deposits are generally worked with high explosives from a vertical face into the quarry opening the depth of which is determined by

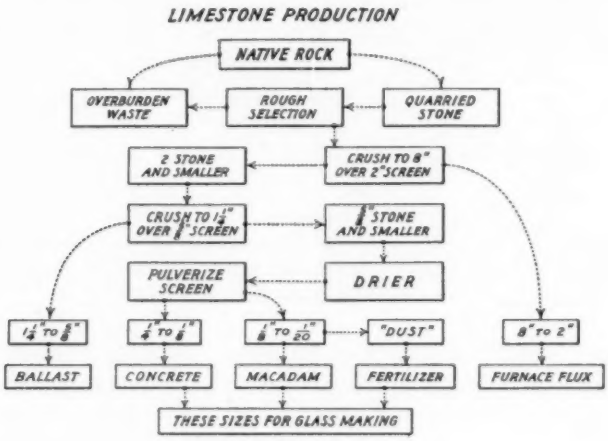


FIG. 1.

the water level and the character of the deposit. Overburden is removed either by hand or with power scrapers. Frequently, if the overburden is very light, no attempt is made to remove it. A rough selection of stone is often made in quarries where quarry cars are loaded by hand, but selection is impractical where loading is done with power shovels. In some districts, the tendency has been in recent years to abandon open quarries and operate underground stone "mines." Mining avoids certain overburden troubles

[1] Window glass is sensitive to oxidizing or reducing conditions in the furnace, somewhat less sensitive, however, than colored or flint glass.

[2] In this connection it would be well to note that the iron content of ordinary window glass is not considered important. Any amount of iron less than 0.25% Fe_2O_3 is considered satisfactory by the present demand of the market.

and permits a very flexible operation independent of weather conditions.[1] Resort has also been made to washing in an effort to eliminate contamination from overburden and mud seams as well as limestone dust.[2] A typical quarry operation is shown in Fig. 1.

The relative amounts of different sizes of stone produced depend somewhat on the character of the native rock. The preparation of the larger sizes always leaves some "fines" for which the quarryman is often glad to find a market. It is apparent from the diagram that any quarry debris from overburden or mud seams will pass through the milling with the fine ground stone. Subsequent screening of the pulverized stone will leave most of the dirt in the last separation. This fact offers a logical explanation to the belief of many glass makers that "fine ground limestone makes stones in glass." Fine ground limestone as a general rule, is more subject to contamination than are the larger sizes.

Just how serious quarry contamination may become is shown by the two tables of analyses of car-lot representative samples from a quarry in the Shenandoah district. Table I apparently indicates a uniform stone of fair quality. It is certain that this stone could not be condemned for glass making on the basis of the chemical analysis. In reality, however, this stone was uniformly contaminated with overburden debris. A very inferior glass was made from this limestone. An investigation of the quarry operation showed that the finished stone contained practically all the foreign matter loaded from the quarry.[3] A rigid selection system in the quarry made possible the production of a much better stone as reflected

I—Quarry Run

Sample	SiO_2	R_2O_3	$CaCO_3$	$MgCO_3$
16217	2.13	0.48	95.37	1.46
16307	2.15	0.38	94.78	1.52
16311	2.24	1.01	94.62	1.65
16325	2.42	1.24	95.29	1.40
16506	2.69	1.66	95.06	0.98
16508	2.36	1.02	95.96	1.14

II—Selected Stone

Sample	SiO_2	R_2O_3	$CaCO_3$	$MgCO_3$
41219	0.66	0.70	97.44	1.08
41220	0.40	0.48	97.44	1.34
41221	0.52	0.52	97.46	1.22
41222	0.64	0.64	97.69	0.84
41224	0.82	0.56	97.13	1.02
41226	0.86	0.64	97.24	0.94

[1] See paper presented by J. R. Thoenen on limestone production as a mining problem before American Institute of Mining and Metallurgical Engineers, Feb., 1925.

[2] Michigan Limestone and Chemical Co., Calcite, Mich. Marble Cliff Quarries Co., Marble Cliff, Ohio.

[3] Microscopic examination of the ground stone by A. E. Williams confirms this point.

by the analyses in Table II. A very excellent quality of window glass was made from this material.

The raw materials for sheet glass making must be of the most uniform quality. Experience has proven that even slight variations will produce striae in the finished sheet. Furthermore, in order that it may successfully resist weathering and surface decay (known as "fading") the best window glass is made with a minimum of alkali.[1] In molten glass of this character clay, and other earthy matter, will not readily dissolve. Such foreign matter, partially dissolved, produces "knots," "lines," "strings," and "stones" in the finished glass.

From the point of view of production losses involved, a few bits of clay found in a car lot of ground limestone, would justify the rejection of the entire car lot. A small amount of such foreign matter is fully as much a source of trouble to a window glassmaker as is a little excess "iron" to flint glass making.

In testing a car lot of material for contamination, it is useless to attempt representative samples. In fact, an effort should be made to pick samples for test from suspicious spots, off color stone, or in corners where segregation may have taken place; quite the opposite of regular sampling practice. In testing for contamination a chemical analysis is apt to be unreliable. For example, in a 90,000 pound car lot of ground stone, one handful of clay would amount to less than $^1/_{100}$ of one per cent but even that small an amount of foreign matter would ruin a considerable quantity of sheet glass.

It is obvious that the allowable variation in composition of the raw materials for glass making should not exceed the permissible error in weighing the batch proportions. The maximum error allowable in weighing batch for sheet glass making should certainly not exceed $\pm 0.4\%$.[2] This limit would permit an error of eight pounds in weighing a batch based on 1000 pounds of sand.

In specifying a limestone it is rather futile to ask a quarryman to produce a stone of a given chemical composition. There are certain objectionable items such as iron, the maximum percentage of which may be specified, but a better practice so far as sheet glass making is concerned would be to determine first whether a quarry exposes a limestone suitable for glass making. A quarry selection and milling routine may then be specified which will enable the *quarry man* to produce the uncontaminated limestone, in a suitable size. In many cases it is, of course, a poor prac-

[1] Eighteen parts Na_2O per 100 parts SiO_2. One of the chief objections to sheet glass made by some methods is the very high alkali content. The high alkali, however, gives a very clear glass free from stones.

[2] Some types of standard equipment will mix batch with an average error well under this limit.

tice for customers to tell operators how to run the quarry. Limestone producers, however, are frequently unfamiliar with the real requirements of the glass trade and welcome any suggestions which will enable them to better satisfy their customers. It is ordinarily impossible to make a complete chemical analysis of every car load of limestone received at a window glass factory, nor is this necessary provided a careful inspection of the material be made in the car for contamination, and traces of foreign matter.

In regard to the use of burned lime versus raw limestone for making sheet glass, there is little published data at hand on which to base a decision, although a considerable amount of window glass has been made from burned lime in the past few years.[1] There is little reason to think that the use of lime effects any material saving in heat or hastens the time of melting.[2] Incidentally, lime is generally more expensive than raw stone as a source of the lime bases.[3]

Items	Limestone	Burned lime
Net cost f.o.b. quarry or kiln	$2.00	$8.00
Freight to factory	2.00	3.00
Cost per ton delivered	4.00	11.00
Approximate total CaO and MgO	56%	97%
Cost per ton oxides delivered	7.15	11.35
Extra cost per ton lime bases from burned lime		4.20
Extra cost per ton glass melted 13.5% CaO, MgO		0.567

The extra cost of burned lime over raw limestone is thus seen to be about $0.50 per ton of glass made.

There is likewise little data on the subject of substitution of dolomite for high calcium stone.[4] By far the larger part of the sheet glass now made in the United States is made from high calcium stone.

In conclusion it may be stated that the proper place to begin the specification of a limestone for sheet glass making is at the limestone quarry. Chemical composition is at best a poor basis for specification. In view of the many very excellent sources of limestone in the United States, a limestone for sheet glass making should certainly contain 97% combined calcium and magnesium carbonates and less than 1% silica. Good window glass can be made, however, from stone less pure. In any case, the ground material must be entirely free from any foreign matter, chert, flint clay, or overburden debris. For ordinary *green* window glass as much as 0.25% iron oxide may be tolerated although in good stone the iron content is

[1] Turner, and others, *Jour. Soc. Glass Tech.*, **5** [20], 188 (1921).

[2] Turner, *ibid.*

[3] Estimated extra cost of burned lime over raw limestone for making window glass. The major parts of lime or limestone which appear in the finished limestone are the lime bases CaO and MgO.

[4] Turner, and others, *Jour. Soc. Glass Tech.*, **5**, 352 (1921); **6**, 101 (1922).

generally much lower than this maximum limit. The proper size of the ground stone depends to a great extent on the mechanical equipment for handling the mixed raw materials. If segregation can be avoided, a coarse stone is to be desired[1] not only because it is less likely to be contaminated with foreign matter but also because of the stirring action of the coarse stone in the melting of the batch in the glass furnace.

WASHINGTON, PA.

NOTE: The author wishes to acknowledge the aid of Messrs. Flint, Shively, Scholes and others in the preparation of this paper.

[1] Past 6-mesh and retained on 30-mesh is a good general size.

DYNAMIC SYMMETRY AS APPLIED TO POTTERY[1]

By Gisela M. A. Richter

ABSTRACT

A presentation of the fundamental principles of dynamic symmetry including an explanation of its mathematics and an analysis of Greek vases. The application of dynamic symmetry as applied to the designing of Greek vases is given.

I am sure that some of you feel that it is rather presumptuous of me to speak to you on dynamic symmetry as applied to pottery, for I am neither a professional potter nor a mathematician. But just on account of my lowly status I may be acceptable to you today; for one of the chief objections against dynamic symmetry is supposed to be its complicated nature. And when a plain average person tells you that she has found dynamic symmetry applied to pottery quite simple, it may have a stronger appeal than if the statement came from an expert potter or mathematician.

My approach to dynamic symmetry was through Mr. Hambidge's work at the Metropolitan Museum of Art. He came to us five or six years ago after having studied the proportions of Greek temples for twenty years or more, and told us that he would like to measure our Athenian vases for he suspected that they would have the same underlying principles of proportion that the Greek temples have.

To me the idea was extremely attractive. I had long felt, as many people who have studied Greek vases doubtless have, that the proportions of the Athenian shapes are so peculiarly satisfying that there must be a definite underlying principle that makes them so; and if by any chance we could find this principle it would be a great discovery; because then we could apply it ourselves. Also it would be interesting to find that such harmonious design is the result, not of slapdash work, but of a system of proportion found also in nature.

Perhaps some of you will think that this is not the way artistic inspiration works. Artistic inspiration, you will say, is something that comes to one suddenly and has to be expressed on the spur of the moment; one cannot sit down with a mathematical mind and work it out. Far be it from me to circumscribe artistic inspiration or to set down rules and regulations concerning it. But as I have come in contact with the mind of the ancient Greeks, certainly an artistic people, it has seemed to me that they were perfectly willing to combine inspiration with law and order; and if they had found some principle of proportion that was in any way useful to design they would have used it. As a matter of fact we know that both in their sculpture and in their architecture they did a great deal

[1] This paper was presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (Art and Terra Cotta Divisions.) Further presentation of this subject will appear in another issue of the *Journal*.

Lecture delivered March 17, 1924 before New York Society of Craftsmen, 65 East 56th St., New York.

of work and spent a great deal of time on just such problems. So when Mr. Hambidge claimed that a definite principle of proportion underlay the design of Athenian vases also, it did not seem to me a preposterous claim.

The Mathematics of Dynamic Symmetry

I will explain first, in a simple and superficial way, the mathematics and geometry used in dynamic symmetry; then show you a Greek vase analyzed according to dynamic symmetry; and lastly the synthetic process of employing dynamic symmetry in designing vases. Throughout I will use Mr. Hambidge's terminology.[1]

Dynamic vs. Static Symmetry

The difference between dynamic symmetry used by the Greeks and static symmetry used by us today is that the former is based on geometry, *i. e.*, on the relation of areas; the latter on arithmetic, *i. e.*, the relation of numbers. In other words, in static symmetry the height of the vase is related to its width in an arithmetical ratio, *e. g.*, as 4 is to 3 or as 5 is to 9.

Dynamic Symmetry is by Areas

In dynamic symmetry the relation is one of areas; and just on that account it makes it easier to use for design. One of the objections sometimes heard against dynamic symmetry is that there are too many possible rectangles and areas. But this is a purely academic objection; for in practice only a small number of rectangles were used together with their logical subdivisions. Very briefly I want to go through this limited number of rectangles. They are the root 2 rectangle, the root 3 rectangle, the root 5 rectangle and the whirling square. On these four rectangles at least 90% of Greek design is based. Let us take them in their order.

$\sqrt{2}$ Rectangle

$\sqrt{2}$ rectangle is produced by drawing the diagonal of a square, using this as a radius, and completing the rectangle (Fig. 1).

AD = sq. $CB = CF$

$AF = \sqrt{2}$ rect.

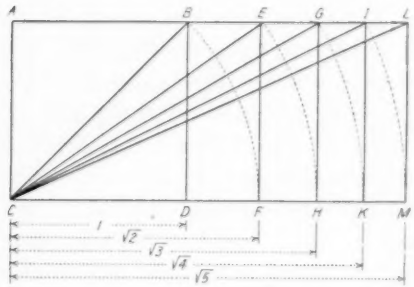


FIG. 1.

$\sqrt{3}$ Rectangle

Use CE in the same figure as a radius, making CH equal to CE and complete the rectangle. AH is a $\sqrt{3}$ rectangle.

$\sqrt{4}$ Rectangle

$\sqrt{4}$ rectangle, which is equal to two squares, is similarly obtained from the diagonal of $\sqrt{3}$ rectangle; and $\sqrt{5}$ similarly from the diagonal of $\sqrt{4}$ rectangle.

[1] For expositions of Hambidge's theories cf. L. D. Caskey, "Geometry of Greek Vases;" J. Hambidge, "Dynamic Symmetry, The Greek Vase;" J. Hambidge, "Dynamic Symmetry," fifteen plates and text; "The Diagonal," 1919–20, edited by J. Hambidge.

These are the root rectangles which concern us here. Their arithmetical ratios, that is, the proportion in these rectangles of their long sides to their short sides are as 1 is to 1.4141 ($\sqrt{2}$), 1.732 ($\sqrt{3}$), 2.236 ($\sqrt{5}$). These figures are rather complicated, it is true, but they are used only in analysis, not in the actual designing. We need not remember them; we can have a list of them and look at them every time we need them.

Whirling Square

Besides these root rectangles there is the rectangle of the whirling square, as Mr. Hambidge has appropriately named it, which is the rectangle par excellence in Greek design (Fig. 2). It is produced by bisecting one side of a square *AD* at *E*, using *EB* as the radius of a circle and completing the rectangle *AG*. The wonderful property of this rectangle is that as *AC* is to *AF* so *BF* is to *FG;* and if you apply a square *ID* in the rectangle *BG*, the remaining rectangle *BI* has the same proportions, that is, as *BF* is to *FG* so *FI* is to *BF;* and if you apply a square inside the rectangle *BI* again the remaining rectangle has the same proportions; and so on ad infinitum. That is, a square whirls around in this rectangle. For short we will call this rectangle "the whirling square." Its arithmetical ratio is 1.618+.

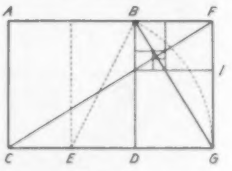


FIG. 2.

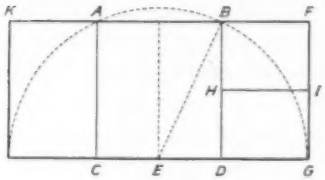


FIG. 3.

If to the large whirling square *AG* you add a smaller whirling square on the other side, namely *KC*, equal to *BG*, the whole figure *KG* is a $\sqrt{5}$ rectangle (Fig. 3). It is the same $\sqrt{5}$ rectangle obtained in a different fashion above; but this shows its relation to the whirling square.

Analysis of Greek Vases

I am not claiming that all Greek vases as you analyze them will turn into simple rectangles of $\sqrt{2}$ and $\sqrt{3}$ and of a whirling square. But analysis has shown that they, or at least the great majority of them, are made up of the multiples and logical subdivisions of these rectangles. In such analysis we must remember that though we can use multiples or divisions, that is, half of $\sqrt{2}$ rectangles or two $\sqrt{3}$ rectangles, we cannot mix them up. If we design in $\sqrt{2}$ we must keep to $\sqrt{2}$; if we design in a whirling square we must keep to the whirling square. Only $\sqrt{5}$ and the whirling square can be combined, for we have seen that the two are intimately related, since a $\sqrt{5}$ is made up of a square and two whirling squares. The whirling square rectangle is the most effective of all rectangles, for it has the most possibilities. For instance, another quality of a whirling square, useful to remember both in analyzing and designing, is that half of a whirling square equals two whirling squares.

Greek Cup

How are these simple principles used in Greek design? Let us take as an example a beautiful Greek cup in the Museum of Fine Arts, Boston (Figs. 4 and 5) analyzed both by Mr. Hambidge and Mr. Caskey, the curator of the classical department

FIG. 4.

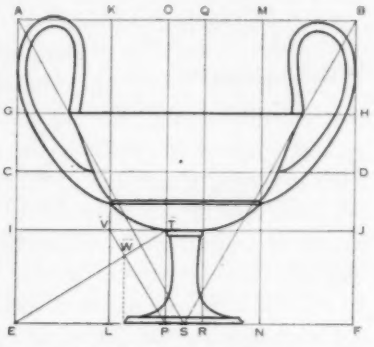


FIG. 5.—Kantharos in Boston Museum.

in the Boston Museum. Their analysis showed that the rectangle which contained the vase, that is, the rectangle made up of its greatest width and its greatest height, consists of two root 5 rectangles superimposed. (In the handles there is a workman's error.)

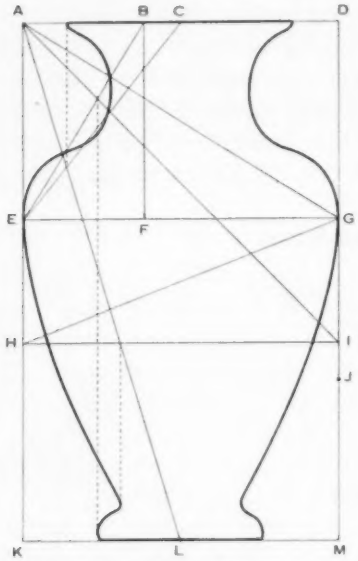


FIG. 6.—Analysis of modern vase. Width = 15.7 cm.; height = 25.4 cm. 25.4 ÷ 15.7 = 1.618 = whirling square. *AI* and *EM* = squares; *AG* = whirling square; *AF* = whirling square.

If four whirling square rectangles are constructed on the four sides of the containing rectangle, namely *AJ*, *EH*, *AR* and *PB*, the overlapping areas *GJ* and *OR* determine respectively the height of the bowl and the width of the stem at its juncture with the bowl.

The diagonals to the two halves of the whole rectangle fix the width of the bowl at the points of their intersection with the sides of the whirling square rectangles. The diagonals *ET* and *VP* to the two whirling squares *IP* and *VP* fix the width of the foot at the point of their intersection.

This is only one example. If you go through Mr. Hambidge's book, "Dynamic Symmetry, The Greek Vase" (Yale University Press, 1920), and Mr. Caskey's book, "Geometry of Greek Vases" (Museum of Fine Arts, Boston, 1922) you will find a large number of

Athenian vases analyzed in this fashion with the same amazing results.

How can we best explain this response of Greek vases to such analysis? Many people believe that it is coincidence and that they would respond equally well to a different analysis. I will only say that if it is coincidence, it is an astonishing one, and that attempts to analyze Greek vases according to the obvious static symmetry have been unsatisfactory, while vases of other countries, for instance the Chinese or Persian, have not been found to conform to dynamic symmetry. The question is still *sub judice*. But I for one feel that if dynamic symmetry—the symmetry claimed to be operative also in nature—is found so readily in Greek design, this may explain the peculiar sense of vitality in Greek art.

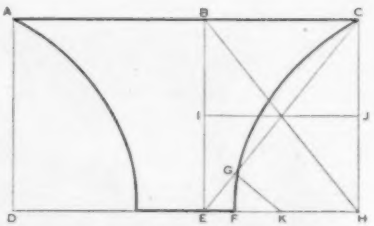


FIG. 7.—Analysis of modern bowl. Width 17.5 cm.; height 9.6 cm.; 17.5 ÷ 9.6 = 1.809 = square plus half a whirling square. AE = square; BH = $^1/_2$ whirling square = 2 whirling squares; IH = whirling square.

Designing Based on Dynamic Symmetry

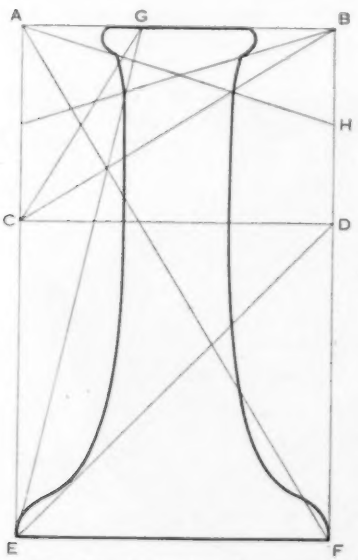


FIG. 8.—Analysis of a modern candlestick. Width 11 cm.; height 17.8 cm. 17.8 ÷ 11 = 1.618 = a whirling square. CF = square; AD = whirling square; GD = square; CG = whirling square; BH = $^1/_2$ BD.

To turn now to the actual designing of vases, I can only tell you the methods I have used in my work, which have seemed to me the most practicable. Doubtless every one who uses dynamic symmetry will do it his own way. First I draw a sketch or several sketches of the pot I wish to make; when I have it about the way I want it I test it by dynamic symmetry. That is, I put it into a containing rectangle, divide the height by the width or vice versa, according to which is the larger measurement, and obtain thereby the ratio. In order to find out whether the ratio is a dynamic ratio I consult a table of these ratios (in which I have put down only the very obvious ones). Let us imagine the height of the vase in our sketch to be 9.7 cm. and the width 17.5 cm. By dividing one into the other we obtain the number 1.804+. This we find is not a dynamic ratio but very near one, for 1.809 is the

FIG. 9.

ratio of a rectangle made up of a square plus half a whirling square. By changing our sketch a little, varying either the height or the width, we can easily obtain a 1.809 ratio. In my experience the changes I have had to make in my original sketches to make them conform to dynamic symmetry have been slight; but invariably I have felt that I improved my design thereby.

Once you have your containing rectangle according to dynamic symmetry you will think how nice it would be if the width of the foot could be in relation to the width and the height of the vase—and the same with the width of the mouth and of the neck. Your vase might then become, you feel, an interrelated theme. And so you proceed. Figs. 6, 7, 8, are three designs I have tried to carry out myself. All are themes in the whirling square rectangle.

These are very simple designs with few subdivisions. The Greek vases are as a rule strongly articulated (Figs. 4, 9 and 10). They are generally narrowed considerably at the neck and the base

FIG. 10.

of the body, the continuity of the curve is often broken at these points, and handles are regularly added. The interrelation of all these subdivisions must have made a very fascinating exercise, and they give to the Greek vase the properties of an architectural building. How important an element this subtly interrelated proportion is can be seen when we look at modern imitations of Greek forms, which, though they often correspond fairly closely in general outline to their models, almost invariably lack the element of vitality so conspicuous in the Athenian products.

Department of Classical Art
The Metropolitan Museum of Art
New York City

THE COURSE IN POTTERY AT THE PENNSYLVANIA MUSEUM SCHOOL OF INDUSTRIAL ART[1]

By Edmund deF. Curtis

ABSTRACT

A description of a simple kiln for firing pottery. The kiln consumes about $1.68 worth of kerosene as against $25.00 worth of city gas which had been previously used. Formulas used at the Pennsylvania Museum and School of Industrial Art are given.

The course in pottery at the School of Industrial Art and Pennsylvania Museum has been planned so that at the end of one full year, three three-hour periods a week, the student will have covered sufficient ground to be familiar with all the decorative processes and to have fairly complete control of his tools and materials and should be able to go ahead on his own account without too many discouragements. I do not mean, of course, that he will be a potter but his work ought to be unhampered by lack of knowledge at least.

Equipment

The equipment at the school is very simple indeed, a few tubs, buckets, brushes, etc., two small grinding mills, two kick wheels and a kiln that we built ourselves. This equipment is not very elaborate but as we do not make any attempt to cover the commercial field it seems to be enough for a class of thirty.

Pottery Making

The clay from Tuckahoe, New Jersey, is soaked overnight in a wash tub, stirred by hand into slip, screened through a rather coarse wire screen and dried in plaster molds to the proper consistency for throwing, coiling or modeling. The student then builds one piece by coiling, using a template to work with. He turns a small bowl upside down out of a solid lump of clay and makes a one piece mold from this original. The next exercise is to turn a vase shape from a plaster cylinder and from this make a plaster section mold.

He casts with the slip into these molds and while the pieces are still plastic trims them and perhaps re-shapes them on the wheel.

Throwing is practiced throughout the year.

The theory of glazes, with enough chemistry to serve as a background, is gone into so that the student is able to make up a formula and work out the batch weights from it and really understand enough of the functions of the different materials to reason himself out of trouble.

The glaze is ground in the ball mills using two parts water to one part gum solution. The latter is made by dissolving two pounds gum arabic in ten quarts of water and straining. The glaze is applied to the unfired clay by dipping, brushing or spraying. The piece must be bone dry and is first plunged quickly into water and then glazed and dried and fired.

The students do all the work themselves and this much of the course

[1] Recd. Dec. 30, 1924. This paper was presented for use at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (Art Division.)

gives them a pretty good understanding of the different methods of making original pieces and reproducing them. Most of the pieces used for practice are cast because I find that if they are working on a built piece they are afraid of spoiling it and that is rather a hindrance in getting control of the clay and glazes, and I think the trimming helps, with the wheel work, which of course is the slowest for them to learn.

Decorating

From this point on for a month or so the work is divided up among the class into problems so that each one does a part of the work and benefits by the work of the others. The different methods of decorating—slip painting under a transparent glaze, painting on the unfired cream or white enamel, incised line, relief decoration, color values obtained by flowing glazes or by spraying, and studies of glaze formula variation and temperature—are all treated in this way. The student goes on from this point with the type of work that appeals most to him and uses the rest of the time in obtaining as much pro-

FIG. 1.

ficiency as he can with a very excellent library at the school and both the Pennsylvania Museum and the University Museum to help him get that intangible feeling for line and color that is so necessary in pottery.

Records

We are trying to make the work cumulative so that each class can go ahead with new problems instead of going over the same ground each year and consequently are keeping the samples on small tiles with the formula, history, temperature, etc., marked over them.

The Kiln

In carrying out our plan to cover as much ground as possible from the technical standpoint we found that a small kiln that could be fired often suited the conditions and as the kiln we had been using consumed $25.00 worth of city gas it was going to be pretty expensive to fire once a week. So in the interests of economy we built a Conestoga kiln similar to the kilns I use in my own work which uses, for a 3 ft. x 3 ft. x 30 in. space about $1.68 worth of kerosene. This

holds just as much pottery as the gas kiln but the ware is fired in the open flame and is not protected in any way by saggers or muffles or tubes. A brief description of the kiln will probably be interesting.

On a suitable foundation about waist high from the floor a single course of fire brick is laid four and one-half inches thick, four bricks high laid up with thin fire clay mortar; over this an arch is turned using mortar half way up and the balance dry; over this shell a stiff mixture of sand and fire clay mud about an inch thick is spread. Then one end of the arch is closed with brick except for the burner hole, about ten inches square and the other end is used for the door and is bricked up each time. A galvanized iron shell is then made going around three sides of the kiln about six inches from the brickwork and the space filled with ground fire brick for insulation. Inside the kiln some brick are stood on end leaving as much open space as possible for the flame and with these as supports and one-inch plates as shelves the ware is loaded. It is usually necessary to give the inside of the kiln a heavy coat of glaze before using it. The door is then put in and the burner started.

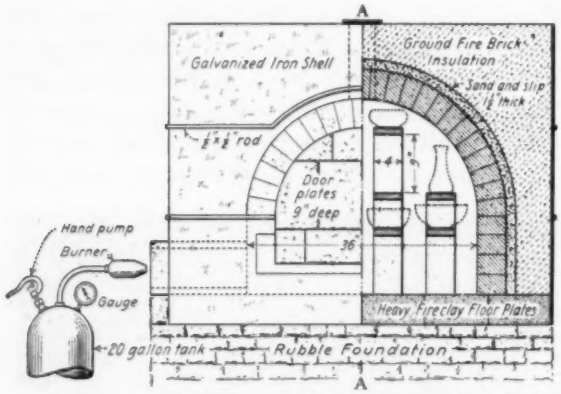


FIG. 2.

The burner is of the atomizing type and has to be preheated which takes only a few minutes; it is connected to a tank holding twenty gallons of coal oil and is kept at a pressure of 40 pounds by means of a hand pump.

A stack is not necessary with these kilns except for ventilating purposes.

The most difficult thing about the kiln is bringing the heat up slowly

enough, but unless there are very large pieces in the kiln one hour at the lowest rate the burner will go is enough, and then the temperature may increase gradually until by the end of two hours it is going full blast, which makes quite a lot of noise but does no damage. The kiln may be finished to cone 3 in about nine hours and the control of the atmospheric condition inside the kiln is positive and immediate which makes many things possible that are very uncertain in the usual pottery kiln. It may be fired twice a week and of course the burner is portable and will handle one kiln a day if there were that many to fire.

I do not know what troubles would develop with other clays and glazes than the ones we use but so far I find at the school and in my own work that aside from carelessness the loss is no more than with other types and of course the repair bill for this type is almost nothing as there is no floor, etc. The burner can be handled so that a heavy reducing condition may

FORMULAS USED AT PENNSYLVANIA MUSEUM AND SCHOOL OF INDUSTRIAL ART, PHILADELPHIA, PA.

White enamel		Black enamel		Turquoise	
White lead	129	White lead	180	White lead	48
Whiting	25	Flint	50	Whiting	24
Eureka Feldspar	83	Kaolin	20	Feldspar	38
Kaolin	13	Tin	15	Kaolin	10
Flint	32	Manganese	15	Flint	57
Zinc	12	Cobalt	7	Tin	10
Tin	20	Copper	5	Soda Bicarb	56
		Chrome	½	Borax	24
				Copper	6

Silver green	
White lead	103
Whiting	25
Feldspar	111
Zinc	12
Kaolin	13
Flint	27
Tin	12
Copper	4½
Cobalt	½

Any of the formulas given in Prof. Binns' "Potter's Craft" may be used.[1]

These glazes are mixed with the right quantity of ⅔ water and ⅓ gum solution mixture and are used without decanting if possible, on unfired ware.

be cleared up in less than a minute and delicate overglaze colors or lusters may be fired with no loss from smoking. I think it took two of us four days to build this kiln and the brick and burner came to something like $150.00.

The type of burner, size and shape of kiln and capacity of tank must be pretty carefully planned but once it is working it certainly is nice to be independent of weather conditions and melting floors. I do not imagine

[1] "The Potter's Craft," D. Van Nostrand Co., 1910.

that it would be economical if the class were large enough to require a coal fired kiln but for this particular course it is most satisfactory.

The Training Given When the student has completed the full course he is supposed to be able to write a paper explaining in detail what, if he had a shop of his own, he would make, how he would make it and where and how he would sell it. It seems to me that there is a future for the potter craftsman. Certainly there is no other material that will lend itself to so many uses and types of decorative methods than clay and a great many articles of everyday use now made by machinery and of metal might easily have the craftsman's touch added and be produced in terra cotta or faience without making the price prohibitive.

The great stumbling block so far in developing this field has been the cost of equipment and the lack of exact knowledge so that the loss may be held down to a reasonable figure and we hope that the work done at the School of Industrial Art will be sufficiently varied in type and use and of a high enough standard of quality to prove that the field may be entered with no great outlay of capital and with a reasonable chance of success.

CONESTOGA POTTERY
WAYNE, PA.

FURTHER EXPERIMENTS IN THE PROBLEM OF THE TURQUOISE ALKALINE GLAZE[1]

By Myrtle Meritt French[2]

ABSTRACT

The blueness of the glaze was found to be influenced by the biscuit of the body, the amount of copper used and the fire of the glaze. Indications of small tests were not always dependable. Encouraging experiments are being made to obtain a raw turquoise on body which will be impervious at cone 04.

Certain results obtained during experiments for the previous article[2] on this subject suggested that a bluer turquoise might be obtained over an immature body than could be produced over a well-fired one. Being desirous that the process should be simple and practical it was decided to try the glaze on the raw body, also to raise the firing point to cone 04, thus making it possible to put the turquoise alkaline glaze in the same kiln with regular low fire work. The desirability of obtaining an impervious body was not lost sight of.

The following new bodies were weighed with the idea of increasing ball clay to make more plastic, and flint to further diminish crazing possibilities.

	No. 10	No. 11	No. 12		No. 10	No. 11	No. 12
Tenn. Ball Clay No. 9..	18	28	28	Flint.....	64	68	68
Eureka Feldspar.....	10			Whiting..	8		4
Kryolith.....		4					

Besides those, clay numbers 3, 4, 5, 6, 8, of the former report were prepared. They were as follows:

	No. 3	No. 4	No. 5	No. 6	No. 8		No. 3	No. 4	No. 5	No. 6	No. 8
Cornwall Stone...			17			Eureka Feldspar.	10	19			14
Tenn. Ball No. 9..	18	14	17	13	18	Kryolith.....	8	8	6	6	6
Georgia Clay.....				19		Flint.....	64	59	60	62	62

Over these raw, dry bodies was applied the same fritted glaze given in the earlier report—namely:

$$\left.\begin{matrix} Na_2O & .6 \\ K_2O & .1 \\ Ca_2O & .3 \end{matrix}\right\} \; SiO_2\ 2.8$$

To this was added 27 grams of black copper oxide to the batch.

For a few hours after the tests came from the kiln none was crazed; but at the end of several days, all had crazed slightly except on the three new bodies.

The next experiment was to determine the amount of copper which would give the bluest color. The above glaze was used as a test. Five batches were fritted, containing the following amounts of copper: 27

[1] Recd. Jan. 26, 1925. This paper was presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (Art Division.)

[2] Continuation of an article published in *Jour. Amer. Ceram. Soc.*, **6** [2], 405 (1923).

gms., 15 gms., 12 gms., 6 gms., 3.5 gms. The superior color ranged from 6 to 12 gms. Lower than that the glaze was not as strong a blue and above 12 gms. the glaze became greener. All were tested on raw clay body No. 12.

At this point, the information gained from the foregoing tests was applied to the making of pieces as tall as eight inches. It was found first that clay bodies containing as high as 6% kryolith were very sensitive to overfire, though when the exact maturing point was reached (and no more) the pottery was satisfactory; second, that the blueness of the same glaze on the same clay fired in the same kiln at the same cone varied considerably with different kiln firings; third, that out of several pieces built of clay No. 12 not one was really satisfactory; the body shivered when matured and leaked when immature, however, the color was the finest blue of all, further indicating that the immature body tends to give a better color; fourth, that often a glaze which would not craze on a small piece would do so on a larger one; and fifth, that the fritted alkaline glazes are always more or less troublesome, because of their tendency to settle into a rock-like mass. Free flint, magnesium sulphate, and mucilage tend to counteract this quality but it is always something to be dealt with—especially when the glazes are to be dried out.

FIG. 1.

Studying the problem from the historical point of view, it seems scarcely probable that the Egyptians or early Persians withstood all these difficulties to produce their bluest turquoise glazes. It is doubtful that they biscuited their ware and it seems likely that the number of materials included in their glazes would be limited. Upon these assumptions, the problem is being approached from an entirely different angle; namely, that of a raw body glazed with a raw glaze compounded as simply as possible and fired at cone 04. A few extremely gratifying results have been obtained, but sufficient material is not at hand to justify a definite report at the present time.

ART INSTITUTE
CHICAGO, ILL.

OBSERVATIONS ON PINHOLING IN CAST WARE[1]

By R. W. Hemphill

ABSTRACT

Some effects of foreign matter, dampness, ball clay content, sponging, dust and drying are shown on pinholing in cast ware.

In our factory we have to be very careful about pinholes, as a piece of cast ware with a single pinhole must either be retouched and refired, or thrown out as scrap. No cast ware can leave the plant with a pinhole, as the forms are used in making dipped rubber goods and a pinhole will cause a blister in the rubber, when it is cured.

Causes of Pinholes

Solid Carbon

Of course there are some general causes for pinholing that everyone familiar with casting knows, such as air in slip, or something burning out of the body. Years ago, before we had filterpresses, we had considerable trouble with pinholes and traced it to some clay that had been shipped in a car that evidently had been loaded with wheat or oats on the trip before. You can well imagine what happened.

Damp Molds

Dampness often causes pinholes in several different ways. Damp molds are bound to cause them as a damp mold will not properly absorb the air out of the slip, when it first is poured into it. This point was very forcibly brought to the writer's attention when experimenting with a mold made so that the top part or cover was too thin. The first casting each day would be all right, but the second and third would be full of pinholes at that part next to the thin part of the mold. The rest of the casting would be free from pinholes. This was no doubt due to the thin part getting saturated or nearly saturated before the rest of the mold, thus trapping the air in the slip.

Contact with Damp Cloths

I have also observed that covering cast ware with cloths that are too wet, will cause pinholes where they touch the casting. We experienced this trouble and it took us quite a while to trace it back to the cause. Every Tuesday our ware would show up pinholes on the top side after the glaze was applied. Of course, it took some time to notice that this trouble occurred every Tuesday. We then traced it back and found that on Saturday afternoon, Saturday's castings were covered with wet cloths to keep them damp so that they could be held over and sponged Monday. This ware was then dried Monday night and glazed Tuesday. By covering the

[1] Recd. Dec. 22, 1924. This paper was presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, February, 1925. (White Wares Division.)

ware first with dry cloths, with the damp cloths on top, trouble of this nature was overcome.

Too Slow Drying Slip Some slips seem to dry too slowly in the molds. It has been my observation that this is a cause for pinholes as it, in some way, traps the air. We had one body that caused considerable trouble this way and our ware was full of pinholes. After the ware was cast and the slip poured out, the ware would have the proper thickness in the mold, but would stay soft and slushy in the mold.

Even after the ware seemed to be stiff, the least little movement or jar would make it again soft and "runny." As previously stated, this seemed to produce pinholes and was overcome by adding a small amount of dark ball clay so that the ware dried properly in the molds.

Too Low Ball Clay Content I have observed that a slip too low in ball clay will pinhole more than one a little higher in ball clay. We cast with as high as 23% ball clay with very good results, but when we get down around 10% ball clay, we get a casting that is literally full of pinholes. Of course, this may be from some other cause that I do not know about, but indications seem to point to the ball clay content.

Incorrect Sponging Then, of course, there are some general points to be brought in about the handling of the cast ware after it has been cast. We find that sponging can be done most advantageously when the ware is leather hard. Of course, the ware must then be properly dried before applying the glaze.

Dust All dust must be removed before the piece is glazed and this can be done by blowing it off, and sponging, or dipping the ware in water. The ware should be cooled down to room temperature before the piece is sponged or dipped in water, and the water should not be below room temperature. Of course, if this operation is done, while the ware is still warm, I suppose the water could be heated up so that the results would be the same. We found that dipping the warm ware caused the ware to crack along the seams where the mold comes together and that it also caused pinholes to appear as blisters on the surface of the green ware. The difference in temperature seems to cause the outer layer or crust of clay to separate and to magnify any defects in the clay body that ordinarily would not show up even in the fired ware.

Ware Not Dry before Glazing Then the ware must be thoroughly dried after the sponging or dipping in water, before the glaze is applied; for if it is not the small defects will then be brought to the surface and bad results obtained.

In glazing the ware, the glaze must not be too thick and the piece must not be held too long in the glaze. Of course, this all applies to single

fired ware. If the glaze is too thick or the piece held too long in the glaze, imperfections will again be magnified.

Ware Must Be Dried before Firing

The ware must also be thoroughly dried after glazing before going into the kiln, as any steam forming under the surface will cause pinholes and defects in the glaze. I might add here that we get much fewer pinholes in single fired ware than biscuit and glost fired ware, and always use the single fire where that method is possible. We can take two pieces cast the same and the single fired piece will be perfect while the two fired piece will be full of pinholes.

Questions

There are many things I would like to know about casting and some are as follows:

Why is it that two slips will apparently cast and work up the same, yet one body will be literally full of pinholes and the other nearly perfect? Also, why will two bodies that have the same total shrinkage when pressed by the dry process, have entirely a different shrinkage, with the same amount of water added, when cast?

Specifications for a Good Casting Body

The body must of course cast and dry properly. It must sponge up smoothly. Some bodies when sponged will be full of ridges and others will sponge up smoothly. Then the body must take a good glaze and fire white. The castings must of course be right for size and must not warp out of shape either in drying or firing. I find that a body high in flint will stay straight while drying and firing, whereas one low in flint will warp considerably. Of course, this is an old theory and no doubt true. Last, but not least, the body must not pinhole.

In closing, I wish to say that it is surprising how unsightly a piece of cast ware can be made to look, unless the utmost care and painstaking effort is used during the process of manufacture.

COLONIAL INSULATOR CO
AKRON, OHIO

SOME FORMS OF SULPHURING ON EARTHENWARE GLAZES[1]

By Thomas A. Shegog

ABSTRACT

A discussion is given of the sources and effects of soluble sulphates on the glaze and body.

The terms "sulphuring," "starring" and "feathering" are used to denote the formation of a scum or film of undissolved sulphates on the surface of a glaze. As Seger[2] has pointed out sulphates may be introduced through the body, the glaze, the water or the fuel.

Sulphates in the Body

Only those soluble in water need be considered; the insoluble ones are harmless. The soluble sulphates are deposited on the surface of the ware during drying as a crystalline scum, especially on corners and sharp edges where evaporation is most rapid. In the bisque kiln this scum is fired on and often shows as a glossy patch. When the piece is dipped and fired in the glost kiln these sulphates may be dissolved by the glaze, and may cause "crawling," or "rolling" or "creeping" of the glaze by preventing it from coming into sufficiently close contact with the bisque body.[3]

"Crawling" is especially liable to occur on vitreous sanitary ware where the glaze cannot adhere to the body as firmly as in ordinary non-vitreous ware. Some years ago the writer had a troublesome case of glaze crawling on the foot of closet-bowls. The trouble was stopped by sandpapering or sandblasting the foot of each bowl before dipping. The same results were achieved more easily by sponging each foot in the clay state after the piece was thoroughly dry.

Likewise it is this scum of sulphates that causes dry edges on plates.

Sulphates from the Fuel

All fuels except wood and natural gas contain sulphur. In whatever form it may occur it is converted during firing into sulphur dioxide, a variable proportion of which is further oxidized to sulphur trioxide. This trioxide, in the presence of moisture, may be deposited in small vesicles on the saggers and the ware in the cooler parts of the kiln at the beginning of the firing and, in the glost kiln, causes, what I have called, "polka-dot" sulphuring. This consists of small dull spots or rings which may be distributed all over the surface of the flat ware, but are more frequently concentrated around the pin-marks, since the saggers at that part are porous and consequently permeable by water-vapor and kiln gases.

The "polka-dot" form of sulphuring consists of dots or rings of sulphate

[1] Recd. Jan. 13, 1925. This paper was presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (White Wares Division.)

[2] "Collected Writings," **2**, p. 647.

[3] Seger, *loc. cit.*, **2**, p. 1147.

scum, each dot marking the position where a vesicle of acid-laden moisture condensed on the ware during the initial stages of the firing in the glost kiln.

With a good mechanical draft it is possible to avoid this condensation to a great extent, but the draft of the ordinary round up-draft kiln is naturally slowest at the beginning of the firing.

Mellor[1] (referring to the ordinary sulphur scum) states that sulphuring is most likely to occur near the end of the firing when the fireman shortens the flame to get the bottoms and so admits a large excess of air to the tops.

Mellor produced a crystalline film of sulphates on glazed tile by heating them in a porcelain tube through which air charged with sulphur trioxide gas was passing, also by re-firing ordinary glazed tiles in a muffle with alum, which on strong heating gives off sulphur trioxide. I have convinced myself, however, that the conditions under which the polka-dot form of sulphuring occurs are present only in the early stages of the firing while the ware in the cooler parts of the kiln is cold enough to permit the condensation of water upon it.

Sulphates in the Glaze

If present in sufficient amount both soluble and insoluble sulphates in the glaze may cause trouble since both will be dissolved by the melted glaze.

According to Seger[2] a bi-silicate glaze can dissolve about 4% of sulphates, while a tri-silicate glaze can dissolve only about 2%. It might seem from this, that reducing the amount of silica in the glaze should reduce, or prevent, sulphuring. This has often been tried but in my opinion it is of doubtful efficacy for, as is well known, the lower the silica in the glaze, the more vigorous is the attack of the glaze on the silica of the body and it seems to matter little whether the glaze is originally high in silica or takes it up from the body.

For sulphuring to take place, it is not necessary for the entire thickness of the glaze to be saturated with sulphates, for as Mellor states: "If the sulphates developed on the surface have not time to diffuse into the rest of the glaze, a film of glaze saturated with sulphates may be produced on the surface of the ware and this on cooling may produce crystals of sulphates." Owing to the high viscosity of the glaze and the consequent slowness of diffusion in it, the relatively high-silica layer formed nearest the body would be slow in affecting the surface and for that reason the expedient may have some merit; for the same reason, however (the slow diffusion), sulphuring can occur when there are not enough sulphates present to saturate the whole thickness of the glaze, so the influence of high or low silica content of the glaze on sulphuring can easily be exaggerated.

[1] J. W. Mellor, "Sulphuring and Feathering of Glazes," Part II, *Trans. Ceram. Soc.* (Eng.), **6**, [1] (1906–7).

[2] Seger, *Loc. cit.*, **2**, p. 646.

Example of Sulphuring

1. Sulphur in Glaze Water

The first case of sulphuring to which I wish to call attention occurred in an oil-fired Dressler tunnel kiln used for glost firing. It was a case of ordinary scum sulphuring but a very severe one.

The top saggers in this kiln were not covered and none of the saggers were wadded. It was found that the top piece of flat ware in every top sagger became completely coated with a scum giving a rather pleasing matt effect in some instances, while many pieces showed the well-known sulphur wrinkles and blisters. Pieces lower down in the bungs were more or less affected, generally near the edges. This condition had continued for some three months. Later on (the Dressler kiln having been shut down for repairs), the ware was fired, some with oil and some with coal, in round glost kilns, with the result that very large losses were incurred from sulphuring, all kilns being affected alike.

After examining the raw materials and the fuels in use, I concluded the cause of the trouble must be sought in the water used in the glaze mills. I found it was the practice to use the same water over and over again, and that to each charge of glaze, a small quantity of Epsom salts was added to help to float it. The repeated re-use of the water naturally brought about a concentration of the Epsom salts. The water from the glaze agitator contained soluble sulphates equivalent to 192 grains of sulphuric acid (H_2SO_4) per gallon.

To stop the trouble, the use of the Epsom salts was discontinued and instructions given that fresh well water be used with each batch of glaze. It was 10 days before a distinct reduction was shown, the soluble H_2SO_4 content then amounted to 161.6 grains per gallon. One week later, it had fallen to 47.2 grains, at which point the sulphuring ceased, and one week later it was down to 2 grains per gallon.[1]

No sulphuring has since occurred at this plant either in the tunnel kiln or in the round kilns except on one occasion about a month later when, owing to a scarcity of dipped ware, the schedule of the kiln was increased from 60 minutes to 90 minutes, and the draft was (by accident) simultaneously cut down to about half normal. Before the normal draft could be restored, a few cars of ware were sulphured.

The glaze on this plant is pumped over, not siphoned.

I may add that the water from the filter presses (which was used over and over again), contained, when I tested it, soluble sulphates equivalent to 23 grains of sulphuric acid per gallon, a quantity which, of itself, seems to be harmless. This case occurred seven months ago.

[1] The H_2SO_4 content of the fresh well water used in the glaze mills was 1.7 grains per gallon.

2. Another Case Re-using Water

The second case occurred almost simultaneously at another plant where round, up-draft, oil-fired glost kilns are in use. It first appeared occasionally as small, dull dots more or less evenly spaced on one or two pieces of flat ware in a kiln. Soon it appeared more frequently and finally was of regular occurrence on most of the flat ware around the pin marks. No method of firing seemed effective in preventing it. This was the first appearance of the polka-dot sulphuring.

As in the other plant, the same water was being used over and over again for grinding the glaze and Epsom salts used to float it.

3. The Same Glaze, but No Sulphuring

At a third plant using the same glaze and materials we did not find sulphur trouble, but at this plant no Epsom salts was used in grinding each batch of glaze and the water was not re-used. A sample of water taken from the glaze-agitator at this plant contained soluble sulphates equivalent to 32 grains of H_2SO_4 per gallon and the glaze was pumped over into the agitator instead of being siphoned.

Limit of Permissible Sulphur Content in Glaze

Being satisfied that the mottled, or polka-dot effect in the second case described was sulphuring, the use of Epsom salts was discontinued and fresh water used for grinding each batch of glaze. The soluble sulphates calculated to grains H_2SO_4 per gallon in the glaze water each succeeding week was:

	Grains		Grains
Original	252.2	Fourth week	97.0
First week	184.4	Fifth week	66.0
Second week	142.7	Sixth week	40.4
Third week	187.0		

At this point the trouble ceased. With the type of glaze used, below 45 grains H_2SO_4 per gallon seem to be harmless.

The sudden increase at the end of the third week was puzzling till I found that the steam used for siphoning over the glaze sometimes contained the equivalent of 102.6 grains H_2SO_4 per gallon while on other occasions it was entirely free from sulphates.

The town water used in the glaze grinding in the second case described had a H_2SO_4 content varying from 1.72 to 9.75 grains per gallon (alum is used to purify). By firing ware from the affected plants at different other plants it was proved that the cause of sulphuring was not from the fuel or firing conditions. All the trials made, pointed to the soluble sulphates in the glaze as the cause of the trouble in both cases. Had it not been that the weekly H_2SO_4 determinations kept us informed of the variations in the amount present, it is doubtful if we should have had the patience to persevere. Without this information we should probably have concluded

that we were on the wrong track and have sought the cause of our trouble in some other direction.

Distinction between Sulphur Scum and "Polka Dot"

The presence of moisture in the kiln and its condensation on the ware is beyond doubt a prerequisite for polka-dot sulphuring. This moisture may be derived from damp ware, the wads, the fuel, and other sources. The sulphates which actually cause the dot must come from the combustion of the sulphur in the fuel and be sufficient, when added to the dissolved sulphates already present in the glaze, to more than saturate these particular spots, being concentrated there in the water vesicles.

The sulphur scum is formed at a later stage of the firing from sulphur trioxide fumes passing through the hot kiln.

The "polka-dot" sulphuring could be produced by an amount of SO_3 insufficient to form a noticeable scum, hence the presence or absence of condensed moisture on the ware must be the determining factor.

Air versus Steam Atomizing Oil Burners

At a third plant experiments on different fuel-oil burners were made. In two types steam was used instead of air for atomization of the oil. No sulphur trouble had at any time occurred at this plant, but in all four firings with steam atomizing burners, polka-dot sulphuring appeared in considerable quantity while no trace appeared when air-atomization was used. Since water from the glaze agitator at this plant showed only a faint trace of sulphates, the sulphuring obviously was due almost entirely to the sulphur trioxide derived from the oil fuel and concentrated in the water vesicles as already described.

Sulphuring in Decorating Kiln

A roughening and darkening of the glaze was found on ware from the decorating kiln on the affected plants. The trouble has been experienced by many but I have not found any explanation for it. I believe it to be an effect of the presence of sulphates in the glaze.

It is well known that up nearly to the end of the decorating kiln fire, the atmosphere of the kiln is strongly reducing owing to the presence of the oils and size on the decals and the usual absence of efficient ventilation of the kiln. I think it very probable that under such conditions the sulphates in the glaze are reduced to sulphites, at least near the surface of the glaze layer. This reduction implies the formation of minute bubbles of oxygen gas in the slightly softened glaze, near the surface and I believe this to be the cause of the roughening of the affected parts. The dark discoloration is almost certainly due to the reduction of lead in the glaze.

The effect appears only in the hottest part of the kiln near the middle and most frequently around the edge of glaze curtains. I regard it as a kind of surface spit-out due to sulphur and developed under reducing kiln conditions. When the sulphuring in the glost kilns ceased this trouble ceased also and has not re-appeared.

R. G. Cowan[1] of Alfred, N. Y., attributes spit-out in general to the presence of sulphur and explains it in a somewhat similar way. I cannot agree that sulphur is the usual or even a common cause of the ordinary form of spit-out since this fault occurs in very many cases when there is no indication of sulphur trouble, and I have always found the particular form of spit-out which I attribute to sulphur, associated with a darkening of the glaze on the affected parts which is not characteristic of ordinary spit-out. Also, the roughness of the darkened surface is much less pronounced than is usual in regular spit-out.

Conclusions

1. Sulphuring of glazes may manifest itself in two forms:

(*a*) Polka-dot sulphuring, which occurs early in glost firing and is due to vesicles of acid-laden moisture condensing on the surface of the glaze.

(*b*) Scum or film sulphuring which occurs later in the firing when the kiln is too hot for moisture to condense on the ware.

2. The use of soluble sulphates, *e. g.*, magnesium sulphate, to float the glaze may cause sulphuring if the same water is repeatedly re-used in the glaze mills.

3. If the amount of soluble sulphates in an earthenware glaze containing about 2.5 equivalent of SiO_2 be less than about 40 grains per gallon (calculated as H_2SO_4) they appear to be harmless under normal firing conditions.

4. Sulphuring in either form may occur with a very slow kiln draft and a long glost fire when under normal firing conditions it would not appear.

5. The use, in glost firing, of steam atomizing fuel oil burners conduces to the occurrence of polka-dot sulphuring.

6. The roughening and darkening of the glaze which sometimes occurs in the decorating kiln is a sulphur effect developed under reducing kiln conditions.

Sebring Pottery Co.
Sebring, Ohio

[1] "Spitting-Out a Phenomenon of the Decorating Kiln," *Trans. Amer. Ceram. Soc.*, **9**, 493 (1911).

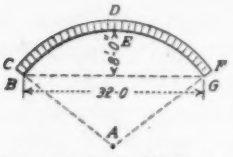
DESIGNING BANDS FOR ROUND KILN CROWNS[1]

By B. W. Willson

ABSTRACT

Selecting bands for round kilns is largely a rule of thumb matter, practice ranging from a few light bands to a jacket enclosing the entire kiln with openings for wickets and fire boxes. The purpose of this paper is to analyze stresses in and thrust caused by a round kiln crown and select bands to with stand these stresses.

Volume and Weight of Crown



Diameter of kiln, 32′ 0″.
From spring of crown, to top of crown, 8′ 0″.
Crown, 9″ fire brick.
2″ platen of common brick.
Required size of band at skew-back.

Fig. 1.

For our problem we shall select a kiln (Fig. 1) 32 feet in diameter, with a rise from spring to top of crown equal to one-fourth of the diameter, or 8 feet, the surface of the crown being a portion of the surface of the sphere. The crown is built with nine inches of fire brick and a two-inch platen of common brick.

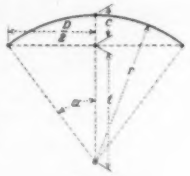


Fig 2.

To find the volume of the crown and therefrom its weight is our first problem. To find the radius of the sphere, whose surface coincides with the under side of the crown refer to Fig. 2.

From plane geometry:

$$r^2 = \left(\frac{D}{2}\right)^2 + l^2$$

$$l = r - c$$

$$\therefore r^2 = \left(\frac{D}{2}\right)^2 + (r - c)^2$$

$$r^2 = \left(\frac{D}{2}\right)^2 + r^2 - 2rc + c^2$$

$$r = \frac{\left(\frac{D}{2}\right)^2 + c^2}{2C}$$

Substituting values:

$$r = \frac{16^2 + 8^2}{2 \times 8} = 20$$

$$\alpha = \sin^{-1}\frac{D/2}{r} = \sin^{-1}\frac{16}{20} = 53^\circ\ 8'$$

[1] Received Jan. 15, 1925. This paper was presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (Heavy Clay Products Division.)

The volume of the crown may be found by several methods. In this calculation the theorem of Pappus will be used, *viz.*, "The volume of the solid of revolution generated by a plane area revolved about a non-intersecting axis in its plane is equal to the product of the area and the length of the path traced by the centroid of the area."

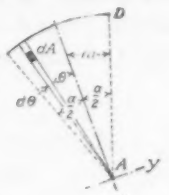


FIG. 3.

The area of a sector of a circle is $\frac{1}{2}r^2\alpha$.

To locate the centroid of the sector of a circle consider it placed as in Fig. 3 with the X and Y axes as indicated. From symmetry, the centroid will be on the X axis.

$$\therefore \bar{y} = 0$$

To determine $\bar{x}$.
From mechanics

$$A\bar{x} = \int x\, dA$$
$$A = \tfrac{1}{2} r^2\alpha$$
$$dA = \rho d\rho d\theta$$
$$x = \rho \cos\theta$$

$$A\bar{x} = \tfrac{1}{2}r^2\alpha\,\bar{x} = \int_0^r \int_{-\frac{\alpha}{2}}^{+\frac{\alpha}{2}} \rho^2 \cos\theta d\rho d\theta$$

$$\tfrac{1}{2}r^2\alpha\,\bar{x} = 2\sin\frac{\alpha}{2}\int_0^r \rho^2 d\rho$$

$$\tfrac{1}{2}r^2\alpha\,\bar{x} = 2\sin\frac{\alpha}{2}\,\frac{r^3}{3}$$

$$\bar{x} = \frac{4r}{3\alpha}\sin\frac{\alpha}{2}$$

The perpendicular distance from the centroid to axis $AD = M = \bar{x}\sin\frac{\alpha}{2}$.

The length of the path of the centroid during one revolution is $2\pi\bar{x}\sin\frac{\alpha}{2}$.

The volume becomes

$$\tfrac{1}{2}r^2\alpha \times 2\pi\frac{4r}{3\alpha}\sin\frac{\alpha}{2}\sin\frac{\alpha}{2}$$

which simplifies to

$$\frac{4}{3}\pi r^3\sin^2\frac{\alpha}{2}$$

Returning to Fig. 1 revolve plane surfaces ACD and ABE about the axis AD and the difference between the volumes thus found will be the volume of the kiln crown. The volume thus found is 1058.62 cubic feet and weight at 125 pounds per cubic foot is 132,327 pounds. Computations are appended.

Thrust of Crown

Referring to Fig. 4, the line of thrust caused by the weight of the crown will be normal to the face of the skew-backs and tangent to the curve of the crown and is represented by the dotted line *DE*.

$$\begin{aligned} \beta &= 180 - 90 - \alpha \\ &= 180 - 90 - 53^\circ\ 8' \\ &= 36^\circ\ 52' \\ DB &= \frac{DE}{\cos \beta} \\ BE &= DB \sin \beta \\ &= \frac{DE}{\cos \beta} \sin \beta \\ &= DE \tan \beta \end{aligned}$$

To find the value of *DE* consider a segment of the crown having an arc of one inch. With a radius of 16 feet an arc one inch long would have a subtending chord so nearly one inch long that no appreciable error will be introduced if we assume the chord the same length of the subtended arc.

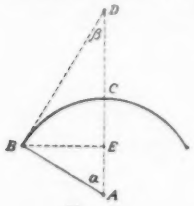


FIG. 4.

The circumference of the crown is $2 \times 16 \times \pi \times 12'' = 1206.4''$.

The volume of segment with $1''$ arc is $\frac{1}{1206.4} \times 1058.32 = \frac{1058.32}{1206.4}$ cu. ft.

Brickwork will weigh about 125 pounds per cubic foot. The weight of a segment becomes:

$$\frac{1058.32}{1206.4} \times 125 \text{ pounds} = 109.7 \text{ pounds}$$

The length of the projected area of the crown is $32 \times 12'' = 384''$.

$$DE = 384 \times 109.7 \text{ pounds} = 42124.8 \text{ pounds.}$$

BE represents the horizontal thrust caused by the weight *DE* and equals *DE* tan β or $42{,}124.8 \times \tan 36^\circ\ 52' = 31{,}590$ pounds.

Size of Bands

This stress is taken evenly by two cross-sections of the band at the skew-back if we neglect the static friction of brick on brick.

The stress per cross-section of band becomes one-half of 31,590 pounds or 15,795 pounds.

The joint efficiency will run about 70% so we must provide a band to take $\frac{15{,}795}{.70}$ pounds = 22,564 pounds.

The safe stress in steel using the customary factor of safety of $2^1/_2$ 12,000 pounds per square inch.

$$22{,}564 \div 12{,}000 = 1.897$$

Provide bands with cross-section area of 1.897 square inches.

Value of Brick Friction

One band 10″ x $^3/_{16}$″ gives practically this cross-section area and would take care of the lateral thrust due to the weight of the crown without counting on the static friction of brick on brick.

For the crown to settle, without change in temperature, it would be necessary for the brick at the skew-back to slip on the course beneath, so that a force equal to the weight of the crown multiplied by the coefficient of static friction is available at all times to help support the crown.

Marks gives $f = .6$ to .7 for brick on brick.

Using the lower value of f and neglecting the strength of the mortar joint we have a force of $.6 \times 132{,}327$ lbs. $= 79{,}396$ lbs. This force is more than twice as great as the horizontal thrust of 31,590 pounds due to the weight of the crown. The lateral thrust is taken by the skew-backs and the frictional resistance of brick on brick transmits this thrust to the course directly below and through each course to the foundation of the kiln. Were it not for uneven expanding and contracting no bands would be necessary on a round kiln. Lovejoy states in his "Burning Clay Wares" that, "after the kiln cooled, we found all bands loose, showing that the kiln wall practically carried the crown thrust."

Selection of Bands

The selection of bands becomes a matter of judgment, backed by experience, rather than one for mathematical calculation. By carefully firing the kiln during the first firing and loosening the bands as the heat advances, the thrust due to expansion is largely taken care of. Corrosion of bands due to rust and often to acid fumes while the kiln is cold causes a heavy loss, which must be met. Harrop recommends one $^1/_4$ x 6-inch band at the crown of a 30-foot kiln. Lovejoy says, "we have had $^5/_{16}$ x 6-inch and $^1/_4$ x 10-inch bands burst on smaller kilns than 30 feet in diameter." It is good practice to use two $^1/_2$ x 6-inch bands so that if one breaks the other will hold.

Computations for Kiln Crown Volume

In sector ABE radius $= 20'$
In sector ACD radius $= 20.9167'$
In both sectors $\frac{\alpha}{2}$ $= 26° 34'$

Substitute these values in formula for volume

$$V = \frac{4}{3}\pi r^3 \sin^2 \frac{\alpha}{2}$$

$$\text{Log } \frac{4}{3}\pi = .6620896$$

$$\text{Log } 20.9167^3 = 3.9614793$$

$$\text{Log } \sin^2 \frac{\alpha}{2} = \frac{9.3010790 - 10}{3.9246479}$$

Anti log 3.9246479 = 8407.13

$\therefore$ Volume ACD revolved = 8407.13 cu. ft.

$$\text{Log } \frac{4}{3}\pi = .6620896$$

$$\text{Log } 20^3 = 3.9030900$$

$$\text{Log } \sin^2 \frac{\alpha}{2} = \frac{9.3010790 - 10}{3.8662586}$$

Anti log 3.8662586 = 7349.51

$\therefore$ Volume ABE revolved = 7349.51 cu. ft.

8407.13 cu. ft. − 7349.51 cu. ft. = 1058.62 cu. ft.

$\therefore$ 1058.62 cu. ft. = volume of kiln crown

Weight of kiln crown = 1058.62 × 125 pounds = 132,327 pounds.

Log 1058.62 = 3.0247401

$$\text{Log } 125 = \frac{2.0969100}{5.1216501}$$

Anti log 5.1216501 = 132,327.

Computations of segment weight:

Log 1058.32 = 3.0246170

$$\text{Log } 1206.4 = \frac{3.0814913}{9.9431257 - 10}$$

$$\text{Log } 125 = \frac{2.0969100}{2.0400357}$$

Anti log − 2.0400357 = 109.743

$\therefore$ One segment weighs 109.7 lbs.

DE = 384 × 109.7 pounds = 42124.8 pounds

Log 109.7 = 2.0402066

$$\text{Log } 384 = \frac{2.5843312}{4.6245378}$$

Anti log 4.6245378 = 42124.8

Log 42124,8 = 4.6245378

$$\text{Log tan } 36° 52' = \frac{9.8750102 - 10}{4.4995480}$$

Anti log 4.4995480 = 31589.9

$\therefore$ DE = 31590 lbs.

National Clay Works
Mason City, Iowa

A MODERN BRICK PLANT[1]

By J. T. Robson

ABSTRACT

A detailed description is given of the layout and construction of a shale brick plant. This plant fires its ware in a tunnel kiln and is built to conform accordingly.

The Denisons who have been among the foremost brick and tile manufacturers in this country, first started operation of a plant in 1877 at Delaware, Ohio, where they have a brick and tile plant in operation at the present time. It was in 1892 at the Delaware plant, that the 5 x 8 x 12-inch tile, now commonly adopted as a standard size in the United States, was first made.

In 1894 they started a plant, since known as Unit No. 1 of the Ohio Clay Co., at Cleveland, Ohio for the manufacture of brick and hollow ware. This unit has since been in constant operation, although almost continuously improved. Its construction and equipment quite largely follows the usual practice except two chamber continuous kilns and one experimental forced draft periodic kiln. All machinery is electrically driven. This Unit No. 1 produces 45,000 tons per annum of good quality ware at low cost.

In 1895 the standard size 5 x 4 x 12-inch tile was adopted. In 1909 at the Ohio Clay Co., the well-known patented Denison Interlocking Tile was first introduced and in 1913 the manufacture of the perforated or "Cle-Clay" brick (Fig. 1) was begun.

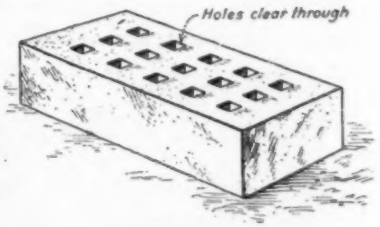


Fig. 1.

In keeping with their progressive attitude, it was quite natural that the Denisons should depart from the old type and fire their product by the better and more modern tunnel kiln method. It was therefore decided to install a tunnel kiln at the Cleveland plant and if satisfactory to make this kiln part of a new unit for manufacturing the "Cle-Clay" brick.

Geo. W. Denison, Vice-President and General Manager of the Ohio Clay Co., who designed this plant, intended to install a tunnel kiln of his own design. He inspected many tunnel kilns throughout the United States and began the designing of one for firing shale brick and building tile. It became apparent to him that the Harrop Car Tunnel Kiln would meet his requirements. This kiln has proven a complete success and made a part of Unit No. 2.

This unit began production July, 1924 and has since been producing

[1] Recd. Jan. 16, 1925. Presented at the Annual Meeting of the American Ceramic Society, Columbus, Ohio, Feb., 1925. (Heavy Clay Products Division.)

100 tons per day (7 days per week) of tile or brick of excellent quality with about $^1/_{10}$ of 1% drier loss and less than 1% firing loss. The maximum capacity of this plant is three times the present capacity production and additional kilns and driers are to be added to realize this maximum.

General Layout

In Unit No. 2 the brick move steadily forward from the machine through the drier. They are then transferred to kiln cars. The layout is shown in Fig. 2. This plant is very compact and simple.

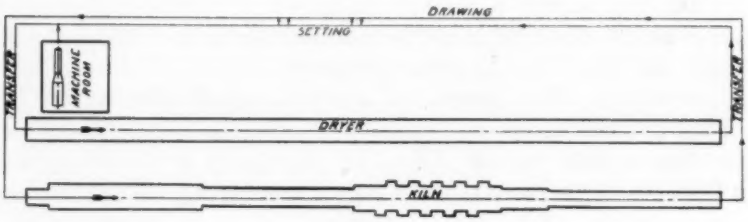


FIG. 2.

Many of its salient features are protected by patents issued and pending, not only the design of some of the equipment used but also the trafficking layout or location of the various units of the plant.

Source of Supply

The material used is Cleveland formation shale, in a bank 120 feet high. The shale is shot down and loaded into approximately 3-yard capacity cars by a Thew electric shovel. The loaded car is hauled by a Plymouth locomotive to the storage pit where the clay is allowed to age. About 300 tons of shale are mined per day. The storage pit will contain 20,000 tons.

Preparation of Material

From the storage pit the shale is transferred to the crusher by a 2-cubic yard capacity clam shell supported on a 112-foot boom. This derrick, together with the crusher house, is shown in Fig. 3.

From the crusher, the shale is belt-conveyed to dry pans and screened through Hummer screens. The screened material is conveyed by a belt 18 inches by 246 feet in length to the storage house. This storage house has a capacity of 200 tons of ground material. It is supported directly above the pug mill by steel I-beam supports.

Machine Room

The ground shale is fed from storage to the pug mill by a disc clay feeder.

The charged drier car is pushed by hand about 30 feet to the three drier tunnels.

FIG. 3.

Five men are required to operate the machine room—the pug mill operator, three hackers and the transfer man.

Fig. 4 shows the machine room in operation.

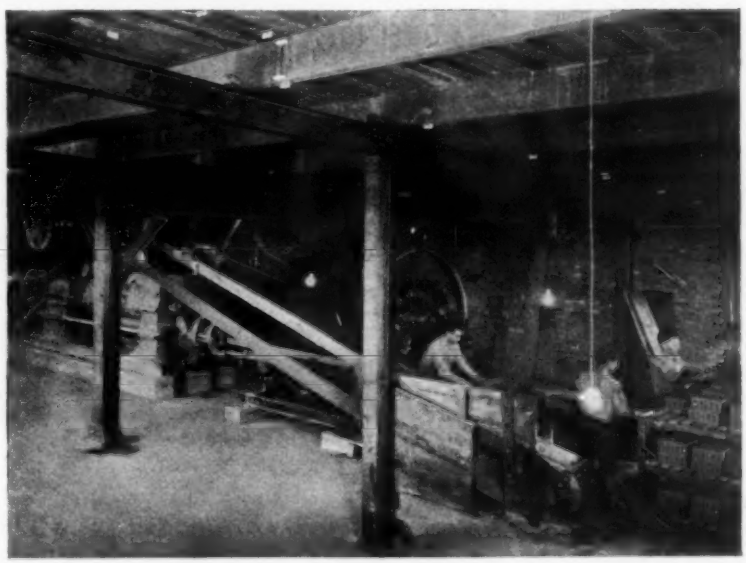


FIG. 4.

Drier

This drier is unique, being designed to fit in with the tunnel kiln. It is located midway between the kiln and the unloading track. It consists of three tunnels each 4 feet wide by $5^1/_2$ feet high and measuring 345 feet in length, almost the same length as the kiln which is 350 feet.

The heat is furnished by an 18-inch flue, which discharges waste directly into each tunnel. The temperature can be regulated by dilution with outside air at the kiln, as described later. An additional source of heat is produced further along in each tunnel by two furnaces each heated with a single oil burner of the W. N. Best low pressure type. The furnaces are located beneath the drier and heat the tunnel by radiation, the products of combustion being drawn off through stacks.

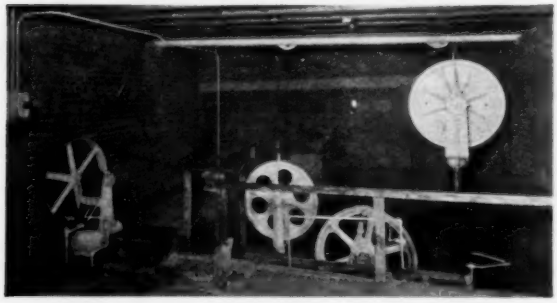


FIG. 5.

The drier is thus in reality a combination of a waste-heat drier and two radiated heat driers in alignment.

The air is drawn down through the tunnel toward the charging end at a high velocity by means of a side discharging fan located in the discharging duct above the tunnels. In this way the green ware comes into contact with air of high humidity, the temperature of which, as it passes down the tunnel, is sustained by means of the furnaces, so that no condensation takes place. The efficiency of this drier is very high, the brick being dried below 2% water content.

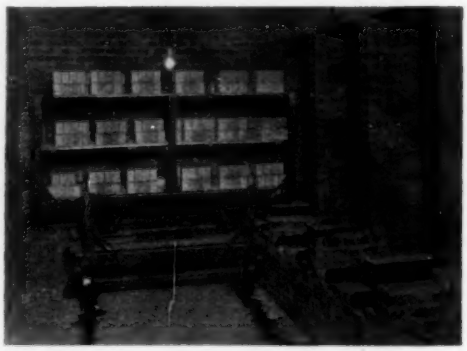


FIG. 6.

Each tunnel holds 44 cars. The cars are pulled through the tunnel by a reciprocating bar extending the entire length of tunnels, to which is fastened lugs which connect with one axle of each car and pull it 7 feet 2 inches. The bar automatically reverses and again pulls the cars forward 7 feet 2 inches, or one car length.

The conveying system is operated by reciprocating hydraulic rams, which are located in a separate room (Fig. 5) beside the discharging end of the drier. At the discharging end of the drier, the cars run onto a transfer car shown in Fig. 8. This is transferred to the return drier track which runs just beside and parallel to the kiln car return track.

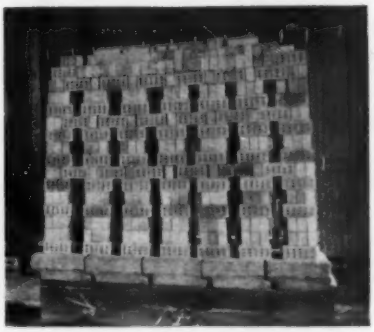


FIG. 7.

Setting of Ware

Each kiln car, 5 feet 11 inches by 6 feet 8 inches, holds more than 2000 bricks. This capacity on each car is made possible by a novel method of setting in piers (Fig 7). There are 7 piers with $3^1/_2$ inch spaces between piers forming flues, which run to the center of the setting into a longitudinal flue about eight inches wide at the bottom. This system of openings of flues allows thorough heat penetration throughout.

The brick are set 17 courses high, the 4-top courses being platted solid. Figure 8 shows the method of setting from the drier cars to the kiln cars. By means of this setting, although the car capacity is very large, the brick

FIG. 8.

are uniformly fired throughout, rendering sorting unnecessary, the entire charge being of No. 1 quality.

Firing

Once every 55 minutes a kiln car is set. The car is pushed by hand into the charging end of the kiln. The whole train is pushed toward

the firing zone by means of a 10-ton capacity Ott hydraulic undercar pusher. Inside the kiln, the ram has a lug, which catches the rear of the car and pushes it forward at the rate of one car length, or 6 feet 8 inches, every 45 minutes. Eight minutes are required for the return stroke of the pusher ram.

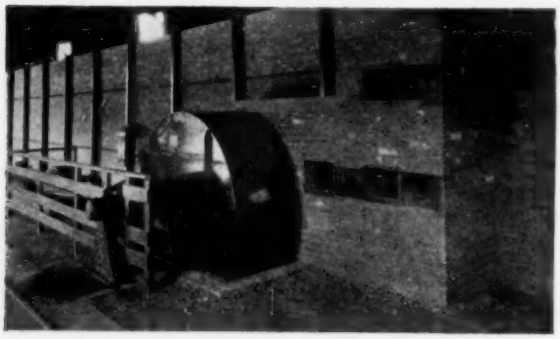


FIG. 9.

As the brick enter the kiln, they come into contact with the warm gases. These gases are drawn down through the kiln chamber proper by means of an exhaust fan and warm air is admitted also through flues above in the crown. This air derives its heat by passing through a double crown over the furnace zone of the kiln. Thus the radiated heat from the crown of the kiln, rather than passing off into the outside atmosphere, is utilized in watersmoking the ware.

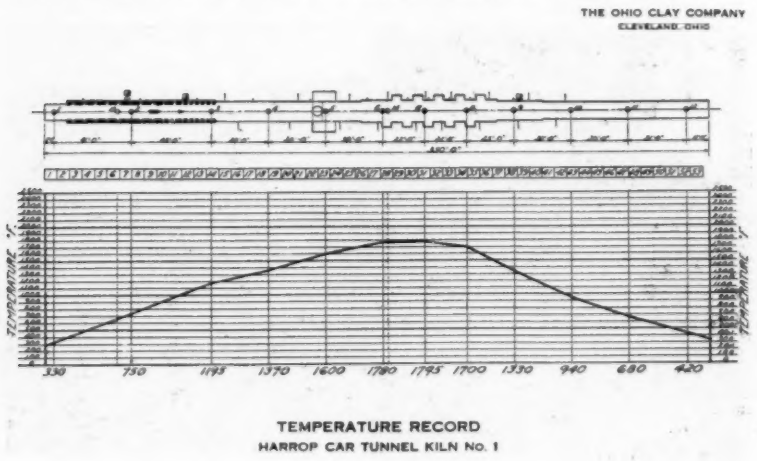


FIG. 10.

The exhaust fan draws the waste gases from the kiln through openings in the kiln side wall and discharges them into the outside atmosphere through a vertical stack 17 feet high. As the ware progresses through the

kiln, it gradually heats up according to the temperature record shown in Fig. 10.

Due to the large amount of carbon present, which is common in shales, and also very excessive amount of pyrite or sulphide of iron, it is very essential to maintain thorough oxidizing conditions in the kiln during the heating up or oxidation period to prevent black coring and bloating. The oxidation in this kiln is complete and the color of the fired ware better than that of ware of same material fired in the other kilns.

Shale usually has a vitrification range of about 100° to 150°F between the point of complete vitrification and that of viscosity, or in other words, between that point where the mass is impervious and that where the mass begins to deform or flow. The range of this shale is not more than 20° to 30°, which is exceptionally low. This makes it necessary that the maximum firing temperature be maintained between 1880° to 1900°F with a draft of 0.4 inch, in order to insure sufficient firing and at the same time to avoid overfiring to deformation. The temperature control of this kiln is so easily maintained that unskilled Italian labor successfully operates it.

FIG. 11.

As the ware passes through the furnace zone, it gradually increases in temperature until it strikes the last or fifth pair of furnaces, where the maximum temperature is attained. Openings on either side of the burners and along the kiln walls allow one to see exactly what is going on in the kiln and the conditions of the ware at all stages of firing.

The fired ware leaving the furnace zone moves along the tunnel toward the discharging end gradually giving up its heat to the incoming fresh air. Part of this air serves as preheated air for combustion and part is utilized for drying the ware. The excess or waste heat for drying the ware is drawn out through two openings on either side of the kiln into a chamber where it is diluted with the desired amount of outside air furnished through openings in the chamber. The two chambers on each side of the kiln are connected by an 18-inch iron pipe passing over the top of the kiln. From here it is forced by a blower through an underground tunnel, 3 feet 8 inches wide and 3 feet high, to the drier. Figure 9 shows one side of this waste heat system. The three open doors are those which admit outside air for dilution. The inside kiln openings are not visible.

The car reaches the discharge end of the kiln in 48 hours. Figure 11 shows a car of fired ware just taken from the kiln.

Figure 12 shows a view of the cars on the return track just ahead of the pusher. Two car lengths ahead of the truck, cars of green brick ready to be fired can be seen. The brick are unloaded directly into the delivery trucks.

Kiln

The kiln is 350 feet long overall and is located under a building 400 feet long by 32 feet wide. This building is constructed of steel frame work and compound corrugated rust-proof metal. The kiln has a straight-end entrance and a straight-end discharge. It has a placing width of 5 feet 8 inches and a placing height of 5 feet 6 inches. There are 10 direct

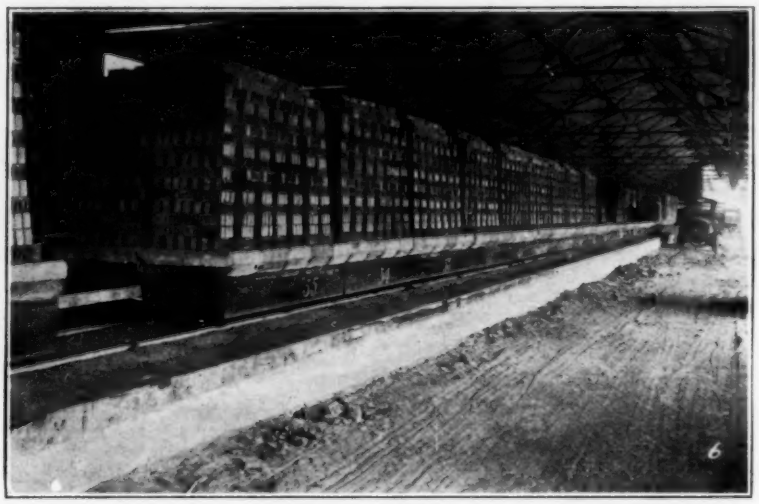


FIG. 12.

oil-fired furnaces, 5 alternated on each side. Figure 13 shows the side of the furnace section of the kiln.

The kiln air supply fan is shown in front at the extreme left. The burners are of the W. N. Best oil-firing type.

The fuel oil used is either of the distillate or residual type, either kind proving to be of equal satisfaction. The oil is stored in two 15,000 gallon steel tanks located underground just between the unloading track and drier. From these tanks it is pumped to the burners under 20 pounds pressure. This pressure is supplied by a Viking oil pump, directly connected to a $^1/_4$-h. p. motor.

The oil line contains the necessary valves and strainers. The system is circulatory with the return line emptying into the oil suction line through a pressure relief valve. This avoids unnecessary travel of the oil and un-

necessary load on the pumps which would be the condition if the excess oil had to be continuously elevated from the storage tanks. All pieces of equipment and lines in this oil system are in duplicate, so that in case any shutdown is required on the circuit being used, the alternate circuit may be opened and the operation of the burners continued.

Air is fed to the burners under a static pressure of 13 ounces per sq. in. by means of a pressure fan revolving at 3400 r.p.m. driven by a 5-h. p. motor.

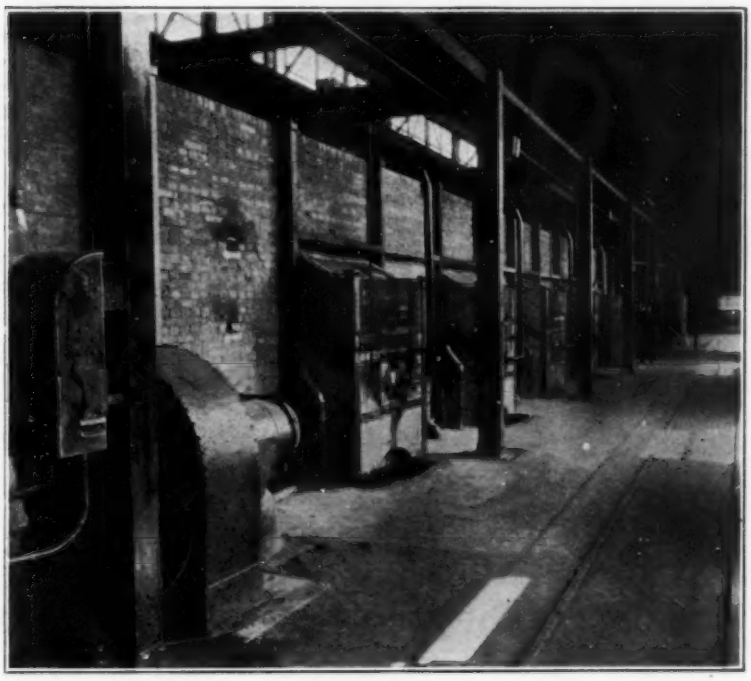


FIG. 13.

An auxiliary steam boiler conducting steam to coils in the bottom of the storage tanks permits heating of the oil to the desired temperature during cold weather. This boiler can be either coal- or oil-fired. This oil system is shown in Fig. 14.

The pyrometer system consists of a Wilson-Maeulen Monopivot Indicator connected with a 30-point switch and a Wilson-Maeulen model C Tapalog, which records the temperature of couples 7 and 8 located in the furnace zone.

Fourteen couples are used. Couples 6, 7 and 8 located in the crown of the furnace zone are of platinum, platinum-rhodium enclosed in double

porcelain protection tubes. The other couples which record lower temperatures are of the base metal enclosed in Iralume protection tubes.

Couples 1–12 are located in the top of the kiln extending down 3 inches through the crown. Couple 13 is located in the watersmoking flue and couple 14 is located in the firing zone underneath the cars. Figure 14 shows the location of the pyrometer indicator and recorder on the switch board.

Draft gages on the kiln record the pressure both above and below the cars, so that the actual conditions under which the kiln is operating are known at all times.

Quality of Product

Tests conducted cover the regular physical tests as prescribed in the specifications of the American Society for Testing Materials involving absorption, compression and transverse tests.

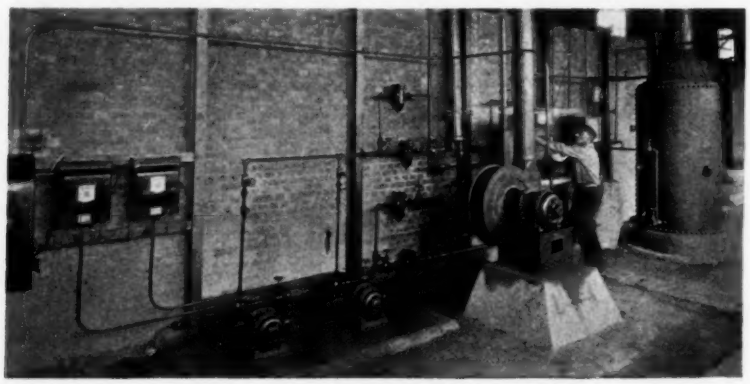


FIG. 14.

In addition special tests[1] were made, such as (1) crushing tests of piers made with brick, using a rich Portland cement mortar, (2) tension tests of the bond of the brick with a rich Portland cement mortar, (3) shear tests of the bond of the brick with a rich Portland cement mortar.

Method of Making Tests

The edge compression test and transverse test were made on a 50,000-pound Riehlé Universal Testing Machine. Likewise the tests for bond in tension and shearing were made with the same machine using special fixtures.

The flat brick and pier crushing tests were made on a 200,000-pound Olsen Compression Testing Machine.

[1] Tests conducted by J. H. Herron Co., Cleveland, Ohio.

Sizes of Brick Used

The Cle-Clay brick was approximately 8 x $3^5/_8$ x $2^3/_{16}$ inches. In the following tests and computations, this brick is considered as a solid brick and no allowance is made for the air spaces. The ordinary common clay brick in the same district was larger. The size was approximately $8^1/_2$ x 4 x $2^3/_8$ inches.

Absorption

(Average of 5 samples.) The average absorption of the Cle-Clay brick was 10.8% and that of the ordinary brick was 18.5%.

Compression

(Average of 5 samples.) In compression, when tested with half brick standing on edge, the Cle-Clay brick broke under a load of 4068 lbs. per sq. in. as compared with 2552 lbs. per sq. in. for the ordinary common brick.

The compression test determined by placing the complete brick on its face gave 7143 lbs. per sq. in. as an average for the Cle-Clay brick and 4542 lbs. per sq. in. for the ordinary brick.

Transverse Strength

(Average of 5 samples.) The average modulus of rupture for the Cle-Clay brick was 665 lbs. per sq. in. and for the ordinary brick, 597 lbs. per sq. in.

Compression Tests of Brick Piers

Brick piers 16 inches high and 8 inches square were laid up with the brick alternating in successive courses, that is, placing the courses alternately as headers and stretchers. One-half inch mortar joints composed of one part Portland cement and 3 parts of well-graded Pelee Island sand were used.

When 28 days old, the piers were tested in a 200,000 lb. testing machine.

In the piers of Cle-Clay brick, failure occurred first at the mortar joint and then through the center of the brick.

In the piers of ordinary brick, failure occurred first through the center of the brick then at the mortar joint.

When failure occurred through both the brick and mortar, the average load for 3 piers tested was 1200 lbs. per sq. in. for the Cle-Clay brick and for the ordinary brick the average load for 2 piers tested was 750 lbs. per sq. in.

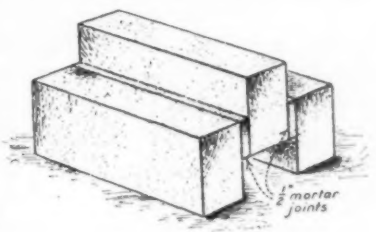


FIG. 15.

Bonding of Brick To Mortar

(A.) In tension (3 samples tested). It required an average force of 50.4 lbs. per sq. in. to pull two bricks apart which were held together by a $^1/_2$-inch mortar joint. With ordinary brick the average force required was 15.8 lbs. per sq. in.

(B.) Shearing Test (3 samples tested). These tests were made using 3 bricks laid up as shown in Fig. 15.

An average force of 328.3 lbs. per sq. in. was required in case of the Cle-Clay brick and only 131.3 lbs. per sq. in. for the ordinary brick.

Conclusion

Cle-Clay brick show low absorption, therefore offering a good opportunity for the proper seasoning of the mortar and prevent the necessity of wetting the brick before laying.

Due to its hardness this brick will stand rough handling and dumping. There will be fewer bats and the corners will be in good condition.

They will stand a much better bearing load since they show a stronger unit value in the wall when laid up and subjected to compression.

The perforated brick make a better bond in shear and tension. They therefore possess an advantage in a wall which is subjected to shear such as a retaining wall or in a wall subjected to tension where there is a tendency to overturn.

The entire credit of this plant layout belongs to George W. Denison, sole originator and designer of the many new and unique principles involved in its construction.

Dept. of Ceramics
Ohio State University
Columbus, Ohio

THE MAKING OF DOLOMITE BRICK AND A STUDY OF THEIR PROPERTIES.—II[1]

By A. I. Andrews, G. A. Bole and J. R. Withrow

Investigation of the Squatting of Brick

The squatting of bricks M2–4–4, M2–4–4E, M2–4–4C and M2–4–4M was suspected as being due to the molasses becoming thin when warmed and flowing, thus causing a settling of the brick material. In order to clear up this question, briquettes were made (dry press) 1 x 2 x 4 inches using 2–4–4M composition and molasses in amounts of 10, 15, 20 and 25%. These briquettes were then dried in room conditions and set on end in an electric furnace and heated to 1090°C in eight hours. The briquettes containing only 10% of molasses as a binder, dusted down, thus showing 10% to be insufficient. The other briquettes on removal from the furnace had a faint odor of molasses; they showed no shrinkage or tendency to squat. It may be thus concluded that the flowing of the molasses as the brick becomes warm does not cause squatting.

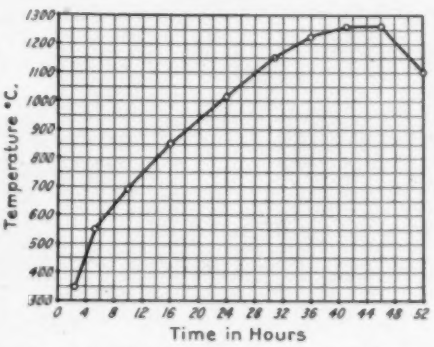


Fig. 14.—Brick firing V. Cone 15 down.

In a further study of this problem, a standard size brick was made up using 2–4–4M calcine and 20% of molasses as a binder. This brick, on firing to cone 15 down (Fig. 14), showed considerable squatting and shrinkage as was evidenced by bricks M2–4–4, M2–4–4E, M2–4–4C and M2–4–4M previously fired. On examination of brick M2–4–4M microscopically, to determine whether the flux was flowing from the top of the brick to the bottom or not, it was found that no difference could be observed between the material taken from the top or the bottom of the brick. If the flux (glass) which is different microscopically from the mineral constituents, flowed to any considerable extent, its presence in the lower part should be greater than in the upper part of the brick. Further, this brick, 2–4–4M, was broken into two pieces and a specific gravity and porosity determination was made of the top and the bottom parts separately. The following results were obtained:

		Density	Porosity
M2–4–4M	upper half	3.11	10.6
M2–4–4M	lower half	3.10	10.7

[1] For the first part of this paper see *Jour. Amer. Ceram. Soc.*, **8** [2], 84–100 (1925). Presented at the Annual Meeting, Columbus, Ohio,, February, 1925. (Refractories Division.)

Since there is practically no difference in the microscopic appearance, the density or the porosity of the top or bottom halves of brick M2–4–4M, it may be concluded that the squatting is not due to the flux flowing to the bottom of the brick.

As the squatting has been shown to be due neither to the binder, nor to the flow of flux, nor migration of material from top to bottom and that it takes place at temperatures above 1090°C, the only conclusion left is that it must be due to the low viscosity of the melted flux or the lack of adhesion between the flux and dolomite particles. It may be stated here that a small briquette 2–4–4 is very difficult to lift with tongs at temperatures from cone 14 up, due to the ease with which it may be crushed. Furthermore, it is very evident that in dead-burning 2–4–4M, 6–3–6M and 9–0–6M, the 2–4–4M becomes much more vitreous than the others. It is thus concluded that 2–4–4M is very weak at temperatures above cone 14 and that the squatting is due to the weakness of the material and not the binder or any migration of a particular part of the material. A general shrinkage (coalescence) of the weakly bonded brick material fails to act uniformly in all directions due to the friction of the base of the brick with the brick on which it rests. Thus the top contracts (squats) while the bottom remains largely unaffected, adhering to the brick upon which it rests rather than developing sufficient cohesion between its individual particles to draw away. Vertical cracks often develop in the base due to this cause.

Binder Study

Since the three most successful bricks thus far produced show considerable shrinkage, it was decided to attempt to find a binder which would not cause fluxing, thus lowering the refractoriness of the brick. It is suspected that the organic binders cause a reduction of the ferric iron of the flux to ferrous iron, probably in the form of ferrous silicate which is very fusible. The addition of sodium silicate which is very fusible, and is an exceedingly active flux has a great tendency to reduce the refractoriness, especially of a basic material such as dolomite. The following binders were then tried out: water, carbonated water, dry tar, crude tar, bindex, magnesium sulphate.

The preliminary binder study is based on the assumption that if a binder is not satisfactory for small sized bodies, it is not likely to be satisfactory for large bodies such as brick, and second, if the binder is satisfactory for small bodies, it is not necessarily satisfactory for large bodies.

A. Molasses, Dextrin and Sodium Silicate as Binders

In order to determine the limitations and adaptability of molasses, dextrin and sodium silicate as binders, the following tests were made:

Three briquettes, 1 x 2 x 4 inches, were made

up (dry press) of each composition and dried very carefully, first at room temperatures and then at 110°C with the exception of those containing molasses which were not subjected to the higher temperatures. The briquettes which dried successfully were then fired, one at cone 14, one at cone 16 and the other at cone 18 down. The porosity and density were then determined by means of the kerosene absorption method previously described.

The compositions used, the percentage binder and the results are shown in the following table:

DRYING AND FIRING RESULTS

Composition	Binder	Per cent binder	Dry	Cone 14 Por.	Cone 14 D.	Cone 16 Por.	Cone 16 D.	Cone 18 Por.	Cone 18 D.	Con.
2–4–4M	Na_2SiO_3	10	Crumb.	...	..	...	..	...	..	NG
2–4–4M	Na_2SiO_3	15	Crumb.	...	..	...	..	...	..	NG
2–4–4M	Dex.	10	Crumb.	...	..	...	..	...	..	NG
2–4–4M	Dex.	15	Weak coarse, and crumbles easily							NG
6–3–6M	Dex.	10	OK	cracked		35.2	3.25	37.6	3.17	NG
6–3–6M	Dex.	15	OK	27.45	2.83	23.95	3.18	20.85	3.22	OK
6–3–6M	Mol.	10	OK	29.00	3.08	10.00	3.03	7.74	3.05	OK
6–3–6M	Mol.	15	OK	swelled						NG
9–0–6M	Mol.	10	OK	41.00	4.02	...	..	26.65	3.26	OK
9–0–6M	Mol.	15	OK	27.3	3.24	26.9	3.08	19.88	3.18	OK
9–0–6M	Na_2SiO_3	10	Crack	...	..	...	..	...	..	NG
9–0–6M	Na_2SiO_3	15	Crack	...	..	...	..	...	..	NG

The sodium silicate binder was a 5% water solution.
The dextrin binder was a one to three mixture of dextrin and water.
The molasses was the same as previously described.

Conclusions

1. Fifteen per cent of the one to three dextrin-water mixture can be used for 6–3–6S composition fired to cones 14, 16, or 18, but cannot be used for 2–4–4M composition under any of the conditions tried.

2. Ten to 15% of molasses can be used for calcine 9–0–6M and 10% molasses can be used for calcined 6–3–6M composition.

3. Fifteen per cent of a 5% sodium silicate solution cannot be used for 9–0–6M or 2–4–4M compositions.

4. From results thus far obtained, it may be stated that molasses can be used for all three compositions, that dextrin can be used for 9–0–6M and 6–3–6M compositions and that sodium silicate can be used for only 6–3–6M composition.

B. Water as a Binder

Water is the logical substance to be used as a binder if such is possible since it is cheap, convenient, and on drying leaves no foreign material to affect the properties of the product.

The following series was designed to show whether or not the ground calcine of any particular mesh size or combination of sizes, possessed

sufficient hydraulic properties to permit its being bound into briquettes by water and at the same time not hydrate sufficiently to crack the body. The briquettes (1 x 1 x 4 inches) were made up by tempering the material with water and pressing in a mold by hand. The following table shows the compositions used and the results obtained:

RESULTS USING WATER AS A BINDER

		Mesh (weight grams)						Fired to cone 16	
Comp.	Fines	200	150	100	65	43	Air dry	Porosity	Density
6–3–6M	140	...	...	...	...	...	OK	7.3	2.55
6–3–6M	...	140	...	...	...	...	OK	8.0	2.66
6–3–6M	...	...	140	...	...	...	OK	cracked	
6–3–6M	...	...	...	140	...	...	OK	cracked	
6–3–6M	...	...	...	...	140	...	OK	cracked	
6–3–6M	...	...	...	...	...	140	difficult to take from mold		
9–0–6M	140	...	...	...	...	...	fine cracks	..	..
9–0–6M	...	140	...	...	...	...	base cracked	..	..
9–0–6M	...	...	140	...	...	...	slight cracks	..	..
9–0–6M	...	...	...	140	...	...	cracked	..	..
9–0–6M	...	...	...	...	140	...	OK but weak	..	..
9–0–6M	...	...	...	...	...	140	OK but weak	..	..
2–4–4M	140	...	...	...	...	...	cracked	..	..
2–4–4M	...	140	...	...	...	...	cracked	..	..
2–4–4M	...	...	140	...	...	...	cracked	..	..
2–4–4M	...	...	...	140	...	...	cracked	..	..
2–4–4M	...	...	...	...	140	...	cracked	..	..
2–4–4M	...	...	...	...	...	140	weak	..	..
6–3–6Ma	20	...	20	20	80	...	OK	cracked	
6–3–6Mb	20	...	...	...	...	80	OK	cracked	
6–3–6Mc	10	...	...	...	110	...	OK	15.2	2.40
9–0–6Ma	20	...	20	20	50	30	cracked	..	..
9–0–6Mb	20	...	...	...	100	...	cracked	..	..
9–0–6Mc	10	...	...	...	110	...	OK but weak	..	..
2–4–4Ma	20	...	20	20	40	40	cracked	..	..
2–4–4Mb	20	...	...	...	20	80	cracked	..	..
2–4–4Mc	10	...	...	...	50	60	cracked	..	..
6–3–6M	100	52	...	50	67	...	cracked	..	..

Some of these fired briquettes are shown in Fig. 15.

Conclusions and Remarks

In the above, better results were obtained in drying when the calcined material had stood a short time in the wet condition before molding. This probably is due to the expansion resulting from slaking which goes nearly to completion before the material is pressed into briquettes.

Schurecht[1] noted this same property in his work when aqueous binders were used. It also appears that coarse material is more easily bound than the fines although at first it is very tender and difficult to remove

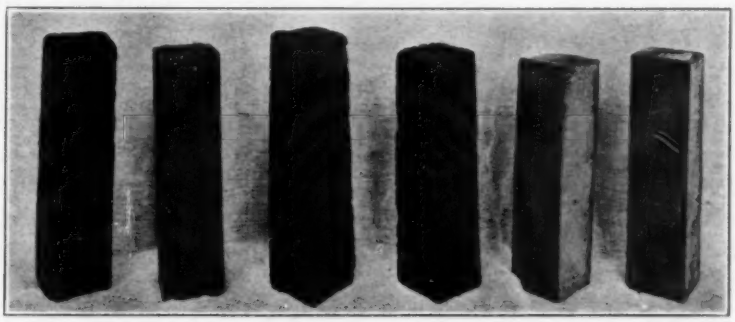
[1] H. G. Schurecht, *loc. cit.*

from the mold. This greater ease of binding coarse material may be due to the greater pore space and chance for expansion due to slaking without disrupting the mass, but it is more probably due to the fact that large particles slake much more slowly than the small ones.

In conclusion it may be stated that it is not feasible to bind any of the above calcined materials hand molded by means of water alone.

Carbonated Water as a Binder

Since success using water alone as a binder was very limited, an attempt was made to use carbonated water and an atmosphere containing carbon dioxide. In this manner it was hoped that calcium carbonate would be formed with any free lime present preventing it from further slaking by coating the oxide and acting as a binder for the rest of the material until high enough temperature was reached to decompose the



1 2 3 4 5 6

FIG. 15.

calcium carbonate. As with water, briquettes 1 x 1 x 4 inches were pressed by hand, using water saturated with carbon dioxide as the tempering liquid.

The compositions and results of this investigation are shown in the following table:

		Mesh (weight grams)						Fired to cone 16	
Comp.	Fines	200	150	100	65	43	CO_2 dry	Porosity	Density
6–3–6Ma	20	...	20	20	80	...	OK	cracked	..
6–3–6Mb	20	...	..	...	20	80	OK	cracked	..
6–3–6Mc	10	...	..	...	110	..	OK	cracked	..
2–4–4Ma	..	...	20	20	40	40	cracked	..	..
2–4–4Mb	20	...	..	...	20	80	cracked	..	..
2–4–4Mc	10	...	..	...	50	60	OK	16.0	2.42
9–0–6M	130	...	..	...	...	..	OK	cracked	
9–0–6M	...	130	..	...	...	..	OK	cracked	
9–0–6M	...	...	..	...	130	..	OK	18.1	2.30
2–4–4M	130	...	..	...	...	..	OK	..	..
2–4–4M	...	...	..	130	...	..	cracked	..	..
2–4–4M	...	...	..	...	130	..	OK	15.2	2.38

Bindex

Bindex is a commercial binder derived from the waste sulphite liquor of the paper mill. As shown in the following table, it was used in solution of 10% and 33% strength, and 15% of this solution was added to the material and was made up (hand mold) into briquettes 1 x 2 x 4 inches in size.

Compn. binder	Per cent	Dry	Firing: Cone 15 Porosity	Cone 15 Density	Cone 17 Porosity	Cone 17 Density	Cone 19 Porosity	Cone 19 Density
2–4–4M	10	cracked	..	..	..	..	...	..
6–3–6M	10	cracked	..	..	..	..	..	..
9–0–6M	10	cracked	..	..	..	..	...	..
2–4–4M	33	OK	25.3	3.13	13.8	3.20	9.56	3.22
6–3–6M	33	OK	25.9	3.04	15.1	3.16	7.4	3.23
9–0–6M	33	OK	28.8	3.15	21.3	3.25	10.8	3.29

Conclusion

Bindex in a 33% solution serves very well as a binder for small briquettes.

Tar

Two grades of tar were used in these tests. One was ordinary dry oven tar and the other was crude oven tar. Both of these tars were thin enough at ordinary temperatures to be mixed with the calcined dolomite without heating. The briquettes were made in one-inch cubes, pressed by hand and dried at 110°C for two hours. Five, 10 and 15% of the tar was added and a sample of each composition was fired to cones 15, 17 and 19 down. The results of these tests are shown in the table (p. 184).

Conclusions

In all cases 5 to 15% tar seems to serve very well as a binder for small briquettes of 2–4–4M, 6–3–6M and 9–0–6M composition fired to cones 15, 17 and 19 down. They appear to be very strong and well shaped with the exception of those made from 2–4–4M composition which show some squatting.

Conclusions of Binder Study as it Refers to Briquettes

1. Tar serves very well in percentages of 5 to 15% as binder for 2–4–4M, 6–3–6M and 9–0–6M compositions in briquettes.

2. Molasses may be used in making briquettes of 6–3–6M and 9–0–6M composition and brick of 2–4–4M compositions.

3. Dextrin only serves as a binder for 9–0–6M and 6–3–6M compositions.

4. Water is unsatisfactory as a binder for 9–0–6M, 2–4–4M and 6–3–6M compositions.

5. Carbonated water and a drying atmosphere containing carbon dioxide show some promise. Coarse material seems to be preferable to fine.

6. Sodium silicate in amounts up to 1% appears to be insufficient for 9–0–6M and 2–4–4M compositions.

7. These results are only approximate where standard size brick are concerned and it was necessary to carry them further by trying out the most desirable binders on standard size brick.

RESULTS OF THE USE OF BINDEX AND TAR

				Firing					
				Cone 15		Cone 17		Cone 19	
Composition	Binder	Per cent binder	Dry	Porosity	Density	Porosity	Density	Porosity	Density
2–4–4M	Dry tar	5	OK	23.90	3.4	14.3	3.02	..	..
2–4–4M	Dry tar	10	OK	20.7	3.13	4.63	2.14	..	..
2–4–4M	Dry tar	15	OK	7.8	2.98	7.22	2.9	..	..
2–4–4M	Crude tar	5	OK	21.4	3.18	15.6	4.14	2.93	2.97
2–4–4M	Crude tar	10	OK	20.95	3.13	14.05	3.06	1.35	2.99
2–4–4M	Crude tar	15	OK	9.22	3.01	9.64	2.99	1.46	3.10
6–3–6M	Dry tar	5	OK	29.4	3.28	17.1	3.19	6.17	3.02
6–3–6M	Dry tar	10	OK	31.6	3.23	16.7	3.23	6.25	3.04
6–3–6M	Dry tar	15	OK	28.2	3.23	13.8	3.17	4.32	3.07
6–3–6M	Crude tar	5	OK	23.2	3.26	14.1	3.2	5.0	3.04
6–3–6M	Crude tar	10	OK	14.8	3.19	15.1	3.18	4.50	3.08
6–3–6M	Crude tar	15	OK	16.7	3.17	11.7	3.09	4.20	3.07
9–0–6M	Dry tar	5	OK	42.0	3.32	25.6	3.24	11.36	3.16
9–0–6M	Dry tar	10	OK	37.1	3.26	17.4	3.26	8.96	3.11
9–0–6M	Dry tar	15	OK	28.0	3.27	20.7	3.13	7.65	3.03
9–0–6M	Crude tar	5	OK	39.2	3.33	26.1	3.26	9.45	3.20
9–0–6M	Crude tar	10	OK	29.2	3.26	19.6	3.24	11.2	3.17
9–0–6M	Crude tar	15	OK	23.4	3.24	18.0	3.28	5.35	3.93

Carbonated Water and Standard Size Brick

Since carbonated water offered some promise as a binder and would not affect the refractoriness of the body, it was first used in an attempt to make brick from 2–4–4M, 6–3–6M, and 9–0–6M dead-burned compositions. Just sufficient carbonated water was added to make the material withstand removal from the mold. The brick were

RESULTS OF THE USE OF CARBONATED WATER FOR STANDARD SIZE BRICK

		Mesh (weight grams)							
Composition	Fines	200	150	100	65	45	20	H_2O	CO_2 dry
2–4–4M	100	..	200	...	100	2100	..	80	cracked
2–4–4M	...	..	400	410	720	100	950	80	cracked
6–3–6M	200	..	...	...	200	2000	100	90	cracked
6–3–6M	500	..	...	...	...	..	2000	150	OK
6–3–6M	500	..	...	...	...	2000	..	150	cracked
6–3–6M	350	..	50	...	300	1800	..	..	OK
9–0–6M	...	..	200	...	500	1800	..	140	cracked
9–0–6M	400	..	200	100	...	800	1000	90	cracked
9–0–6M	500	..	...	...	...	..	2000	150	cracked
9–0–6M	400	..	...	...	...	2100	..	150	cracked

then placed in a chamber at room temperature into which a slow stream of CO_2 gas was continuously passed. The preceding table shows the screen analysis and composition of the brick made up and the results obtained.

Conclusion

These results show that the use of CO_2 in bonding dead-burned dolomite, although it gives a hard and firm body, generally results in cracking when dried.

The brick which are marked OK in the above table cracked on standing in the air for several days. All these brick were then broken up in a mortar and repressed into brick as before with carbonated water and again dried in a CO_2 atmosphere. Again the brick cracked on drying. The surface of the brick was very hard but in spite of the slow drying, the inside of the brick dried slower than the outside and caused cracking. It was then decided to abandon the use of CO_2 as a binder due to the extreme difficulty in drying. However, in order to determine whether a brick could or could not be dried in a humid atmosphere using water as a binder, 6–3–6M was made up of 500 grams of 200-mesh and 3000 grams of 48-mesh residue and tempered with water. This brick was pressed at 500 pounds per square inch and placed in a container over warm water with only an opening to reduce the humidity slightly below 100. This brick crumbled completely and did not appear to be nearly as good as one dried in air. This is likely due to the continued slaking of the dolomite in the humid atmosphere and resulting expansion and disruption. It was then concluded that humidity drying is not practical for dolomite brick due to the hydration of the lime.

Bindex and Tar for Standard Size Brick

In order to determine the real value of bindex and tar in the binding of dolomite clinker, these binders were used in making up standard size brick of 2–4–4M, 6–3–6M, and 9–0–6M dead-burned compositions of the following screen analysis.

	Per cent residue		
Mesh	2–4–4M	6–3–6M	9–0–6M
10	0	0	0
20	10.40	12.00	23.31
48	48.00	43.70	30.06
65	15.74	11.86	22.30
100	9.95	8.21	6.01
150	3.97	7.47	3.22
200	8.82	7.47	2.30
Fines	3.12	9.29	12.80
	100.00	100.00	100.00

In making up these brick, 3000 grams of the calcined dolomite were used for each brick.

Brick 2–4–4MB, 9–0–6MB and 6–3–6MB These brick were made by adding 10% of a 33% solution of bindex to the ground clinker, mixing, and molding at 500 pounds per square inch. On drying under room conditions, 6–3–6MB withstood the drying very well but the other two bricks swelled and cracked badly within a few hours. On repressing at 500 pounds per square inch and drying at 110°C in an oven, they swelled and crumbled down completely within thirty minutes. It is likely that this rapid disintegration is due to the acidic character of the bindex accompanied by hydration. It may thus be concluded that bindex cannot be used to bind calcined compositions 2–4–4M or 9–0–6M dead-burned in the form of brick.

The two types of tar used with briquettes (page 184), dry tar and crude tar, were used in making standard size brick. To three kilos of each composition 2–4–4M, 6–3–6M and 9–0–6M, 10% of dry tar was added and to three kilos more of each, 10% crude tar was added. These compositions were then pressed into brick at 500 pounds per square inch after which they were dried for several days, at room temperature, and set very hard and firm.

The following brick were also made up:

Brick M9–0–6ED To the reground material from the unsuccessful brick 9–0–6E, 20% of molasses was added, mixed and pressed into a brick at 500 pounds per square inch. This brick dried well in room conditions.

Brick 6–3–6E CO_2 To the reground material from unsuccessful brick 6–3–6E, a saturated solution of carbon-dioxide was added and it was then repressed into a standard size brick at 500 pounds per square inch. It was dried in an atmosphere containing considerable carbon dioxide. It showed no cracks and was very firm and strong.

Brick 6–3–6M–$MgSO_4$ Schurecht[1] successfully used epsom salts ($MgSO_4$) as a binder for calcined dolomite. The object of which was to form $CaSO_4$ with any free lime present and thus bind the material together. $MgSO_4 + Ca(OH)_2 \longrightarrow Mg(OH)_2 + CaSO_4$.

To compositions 6–3–6M, 2–4–4M and 9–0–6M 5% of a saturated solution of $MgSO_4$ was added and the batch pressed into brick. These brick, however, cracked on drying. Ten per cent more of the $MgSO_4$ solution was then added and the brick repressed but again the brick cracked on drying. It was thus concluded that $MgSO_4$ could not be used as a binder for the above compositions.

Brick 9–0–6MD In an effort to form brick dry by using dextrin, the ground clinker was wetted with 15% of a one to three dextrin-water mixture and then dried. It was then put in the brick

[1] H. G. Schurecht, *loc. cit.*

mold and pressed at 500 pounds. On standing for six hours, it showed cracks and later dusted down completely.

Brick 9–0–6MS To 3000 grams of 9–0–6M composition, 300 grams of shellac were added and mixed thoroughly. The batch was then pressed at 500 pounds per square inch and dried at room temperatures. At the end of two days it was cracked badly.

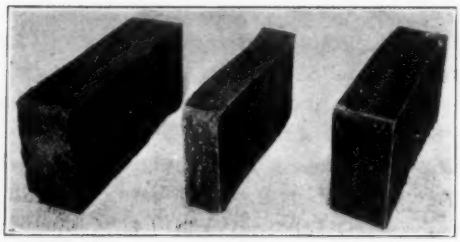
Brick Firing No. 5

Bricks 6–3–6MB, 2–4–4M + 10% dry tar, 2–4–4M + 10% crude tar, 9–0–6M + 10% dry tar, 9–0–6M + 10% crude tar, 6–3–6M + 10% dry tar, 6–3–6 + 10% crude tar, M9–0–6ED, M2–4–4M and 6–3–6ED were included in this firing.

As in previous firings, these brick were set on end on magnesite brick dusted over with 20-mesh magnesite brick grog. The dolomite brick were protected from the direct flame and fired to cone 15 down according to Fig. 14.

Results of Brick Firing No. 5

1. All tar bound brick cracked and fell apart during firings. Fig. 16 shows 2–4–4M + 10% dry tar after firing.



6–3–6MB 6–3–6E CO_2 2–4–4M

FIG. 16.

2. Brick M9–0–6ED cracked badly.

3. Brick 6–3–6MB cracked and squatted badly (Fig. 16).

4. Brick 6–3–6E CO_2 warped badly, leaning over and fluxing with an adjacent fire brick (Fig. 16).

5. Brick M2–4–4M squatted as has been previously described for this brick.

Conclusions

1. It is not feasible to use 10% tar as a binder for the above clinker.
2. Bindex cannot be used as a binder for clinker of the 2–4–4M or 9–0–6M compositions.
3. Dextrin and molasses together as binders for 9–0–6 compositions are unsatisfactory.
4. The warping and leaning over of brick 6–3–6E CO_2 is likely due to the large amount of Na_2SiO_3 contained.
5. The best binders for dolomite brick thus far used are:

(*a*) 2–4–4M 15% molasses.

(*b*) 6–3–6M 10% of a 5% solution of Na_2SiO_3.

(*c*) 9–0–6M 10% of a one to three dextrin-water mixture.

6. The following binders were not successfully used: bindex, tar, $MgSO_4$, dry dextrin, water, carbonated water and shellac.

Effect of Grain Size on the Rate of Slaking of Calcined Dolomite

Calcined dolomite of the various compositions already mentioned was ground and screened. Samples of about 20 grams were taken from the various sizes and exposed to the room conditions in an open crystallizing dish. These samples were protected from dust by means of a roof and canopy of cheese-cloth. The samples taken and the results of the tests are shown in the following table. Under the heading "mesh," 48 means that the sample passed 20-mesh but was residue on 48-mesh, 100 means through 65-mesh but residue on 100-mesh and 200 means through 150-mesh but residue on 200-mesh.

EFFECT OF GRAIN SIZE ON RATE OF SLAKING OF CALCINED DOLOMITE

Composition	Mesh		Per cent gain in weight (days)					
			1	2	5	9	15	26
2–4–4M	48	8	0.05	0.08	0.18	0.29	0.38	0.48
	100	8	0.06	0.12	0.28	0.87	1.47	2.68
	200	8	0.13	0.26	0.89	1.69	2.47	4.81
2–4–4M3	48	9	0.06	0.12	0.36	0.78	1.11	2.10
	100	9	0.08	0.22	0.70	1.52	2.16	3.18
	200	9	0.21	0.56	1.79	3.67	4.81	6.13
2–4–4M2	48	10	0.06	0.12	0.37	0.76	1.07	1.58
	100	10	0.10	0.27	0.83	1.86	2.56	3.73
	200	10	0.33	0.51	1.59	3.38	4.17	5.94
9–0–6M	48	11	0.01	0.03	0.11	0.19	0.23	0.34
	100	11	0.03	0.08	0.26	0.42	0.57	0.80
	200	11	0.06	0.16	0.47	0.89	1.17	2.00
9–0–6M3	48	12	0.06	0.17	0.50	1.12	1.64	2.51
	100	12	0.12	0.35	0.85	1.78	2.53	3.79
	200	12	0.32	0.87	2.37	5.11	6.69	8.59
9–0–6M2	48	13	0.07	0.19	0.56	1.29	1.87	2.81
	100	13	0.11	0.34	1.12	2.10	2.93	4.33
	200	13	0.36	1.00	2.37	5.69	7.40	7.78
6–3–6M	48	14	0.02	0.07	0.17	0.20	0.39	0.50
	100	14	0.04	0.11	0.30	0.55	0.73	1.00
	200	14	0.09	0.27	0.83	1.48	1.84	2.06
6–3–6M3	48	15	0.03	0.09	0.25	0.44	0.60	0.81
	100	15	0.06	0.16	0.31	0.60	0.84	1.48
	200	15	0.13	0.36	1.07	2.08	3.11	4.08
6–3–6M2	48	16	0.04	0.12	0.33	0.68	0.96	1.43
	100	16	0.10	0.25	0.69	1.59	2.46	3.23
	200	16	0.16	0.45	1.41	2.98	4.03	5.39

From the results as shown by the above table and Figs. 17–25, it may be stated:

1. For a single composition, the smaller the particle the greater the increase in weight on exposure to the atmosphere for a given time.

2. Of the compositions and mesh listed, 150–200 mesh 9–0–6M2 shows the greatest increase in weight in 1, 2, 5, 9, 15 and 26 days while 9-0-6M3 shows very nearly as great.

3. Of the samples used in brick, 2–4–4M shows a decidedly greater tendency to take on weight than 9–0–6M or 6–3–6M, the results on the latter two compositions being nearly equal although 6–3–6M is slightly greater than 9–0–6M.

Conclusions

From these results it is concluded that this ground clinker is susceptible to the action of the atmosphere and that any prolonged storage is likely to be deleterious to the material.

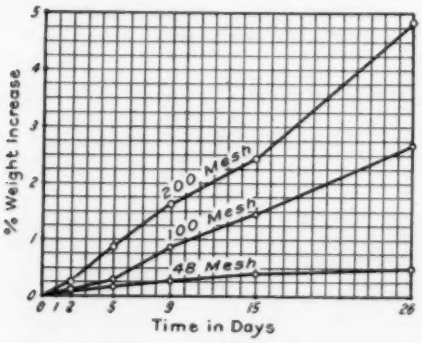


FIG. 17.—2–4–4M. Slaking tendency.

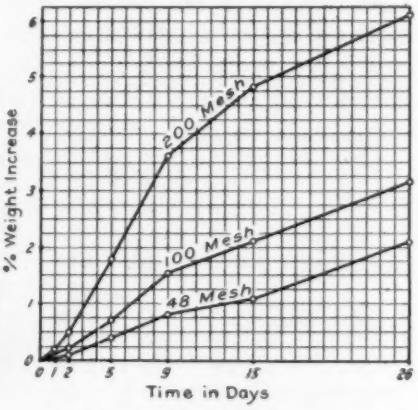


FIG. 18.—2-4–4M3. Slaking tendency.

Fluxing Investigation

In the dead burning of dolomite it is necessary that a refractory be employed with which the dolomite does not react at high temperatures. Neutral or basic refractories have been found to be the best.

Raw dolomite plus flux can be calcined at cone 20 on magnesia brick dusted over with a small amount of magnesia brick grog. If a silica brick is used, a very thick layer of this magnesia brick grog is necessary as the dolomite in calcining rapidly fluxes with the silica until one or the other is entirely destroyed. A kaolin fire brick is also attacked in this manner and the flux becomes even more liquid than in the case of a silica brick. If the layer of magnesia brick grog is thick, however, and the load on it is not too great, the dolomite does not get to the silica or fire clay brick and thus does not flux.

In firing bricks M2–4–4M, S6–3–6M and D9–0–6M on silica brick, the fluxing is very much less than in dead-burning even when carried to a temperature of cone 18. There is, however, a decided reaction resulting

in a formation of dust at the point of contact between silica and dolomite.

Chromium oxide is neutral to the dolomite and prevents fluxing. Dolomite may be conveniently fired on chrome brick.

From the above it may be stated that dolomite fluxes energetically with refractories of acidic nature but does not flux with neutral or basic refractories.

Dead-Burning Dolomite

In order to increase the refractoriness of the clinker, an attempt was made to use less flux and heat to a higher temperature than that used by Robson and Withrow.[1] This test consisted in calcining the following

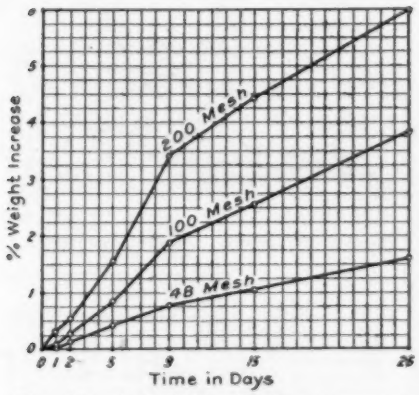


FIG. 19.—2–4–4M2. Slaking tendency.

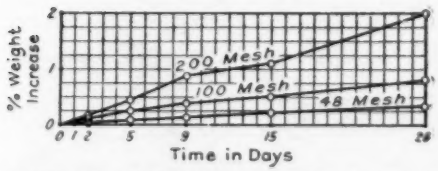


FIG. 20.—9–0–6M. Slaking tendency.

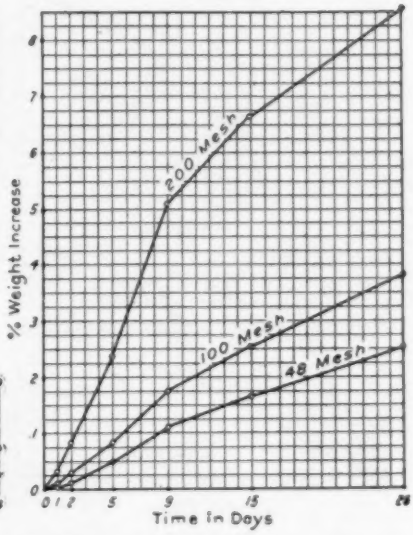


FIG. 21.—9–0–6M3. Slaking tendency.

compositions made up with water to a plastic condition and pressed into briquettes 1 x 2 x 4 inches by hand: 2–4–4M, 6–3–6M and 9–0–6M using $^1/_2$ and $^2/_3$ of the specified amounts of flux. After firing these briquettes to cone 20, the following tests were made:

A. Inside Air Slaking Test — Allow the briquettes to remain exposed to the room conditions and note any change in weight or appearance as time goes on.

B. Outside Air Slaking Test — Allow the briquettes to remain exposed to the weather (December to April), noting any change in weight or appearance.

[1] *Loc cit.*

C. Warm Water Slaking Test

Allow the briquettes to rest on a screen in water kept at 75–85°C until they show disintegration.

The following table shows the composition of the various briquettes and the results of the tests just described:

Comp.	Per cent flux	A 4 mo.	B 4 mo.	C Disintegrated,
2–4–4M2	5	no change	no change	1 day
2–4–4M3	7.5	no change	no change	9 "
6–3–6M2	7.5	no change	no change	12 "
6–3–6M3	10.0	no change	cracked 3 mo.	9 "
9–0–6M2	7.5	no change	no change	1 "
9–0–6M3	10.0	no change	no change	1 "

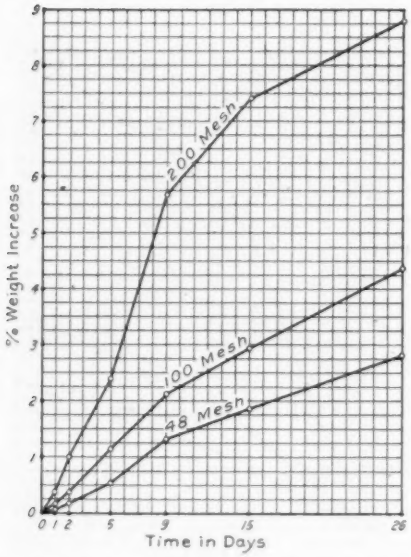


FIG. 22.—9–0–6M2. Slaking tendency.

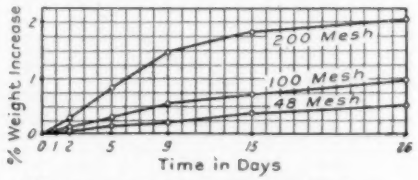


FIG. 23.—6–3–6M. Slaking tendency.

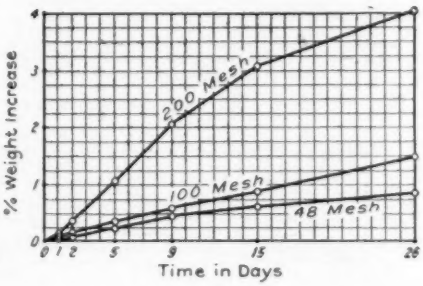


FIG. 24.—6–3–6M3. Slaking tendency.

This shows that less flux can be used if the briquettes are not exposed to severe conditions, but the resistance to slaking is much diminished. See Robson and Withrow.

Since talc is a compound of magnesia and silica, it might easily be suspected of making a good flux for dead-burning dolomite. It was thus tried out in the following experiment:

Maryland and California talc was used in making up briquettes 1 x 2 x 4 inches of 5, 10, 15 and 20% talc with dolomite. These were fired to cone 20 down and subjected to the same tests as the briquettes just described. The briquettes with 20% California talc dusted down on cooling. The others were all hard and firm but, as shown in the following

table, they are not very resistant to hydration. The same key is used at the head of the columns as in the table above.

Comp.	Talc.	Per cent talc.	A days	B days	C
TC5	Calif.	5	1	1	1 hr.
TC10	Calif.	10	3	1	1 hr.
TC15	Calif.	15	24	8	1 day
TM5	Md.	5	3	7	1 "
TM10	Md.	10	8	7	1 "
TM20	Md.	20	20	6	1 "

These results show that talc does not satisfactorily act as a flux for dead-burning dolomite under the above conditions.

Cone Fusion Tests

The pure dolomite cones in an Ajax-Northrup induction furnace (Fig. 26) showed a fusion test lower than could be justified; it is believed that the reducing conditions in this furnace were the cause of error. The standard cones in all cases were coated with a grey film which was extremely hard, scratching glass, and which bloated the cones. It is believed that this is a solution of carbon in the cone material which reduces the fusibility of the cones. It is a commonly accepted fact that cone fusions are unreliable in a strongly reducing atmosphere. Since the atmosphere of this furnace is in direct contact with carbon on all sides, it is strongly reducing. Due to this fact and the unreliability of the tests made, another type of furnace was found necessary.

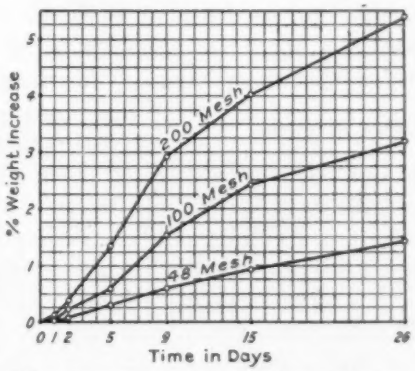


FIG. 25.—6-3-6M2. Slaking tendency.

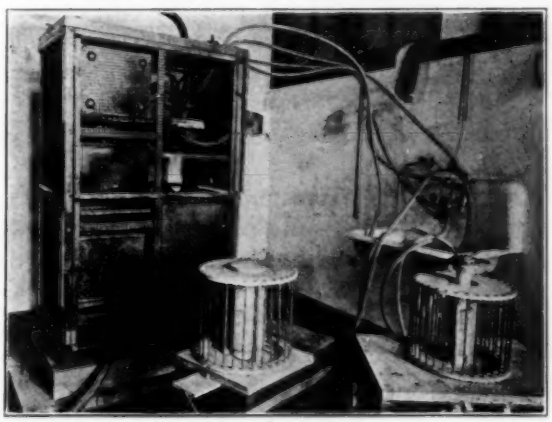


FIG. 26.—Ajax-Northrup induction furnace.

Oxyacetylene Furnace

Since a gas-air furnace does not give the required temperatures

and the electric furnaces other than the Ajax-Northrup have the same fault, an oxyacetylene furnace was built. This furnace was built on the principle of that of Wilson.[1]

An iron container, one foot in diameter and 14 inches high was used as the shell. Twenty-mesh magnesia brick grog was used as the refractory material. A dextrin-water binder (1–3) was used to bond the magnesia which was tamped into the shell, leaving a combustion chamber 10 inches deep and $3^1/_2$ inches in diameter. At the base of this vertical chamber were two channels two inches in diameter entering tangentially from opposite sides. Oxyacetylene welding torches were arranged so that the flame caused a spiral motion. At the base of the combustion chamber and in the center was placed a cylinder $1^1/_2$ inches in diameter and 2 inches high on which to place the cone plaque. On this cylinder was placed a layer of chromium oxide to prevent sticking to the plaque. Using the above furnace, the following investigation was carried out:

Cone Plaques For the standard cones, a highly refractory clay bauxite mixture was used, being made up into plaques and fired to cone 20 down. For the dolomite cones, a plaque was cut out from a magnesia brick.

In order to determine the efficiency and uniformity of the heat in the furnace, a cone plaque containing cones 32 and 33 alternately placed, was put into the furnace and fired. The results were very satisfactory, cone 32 going down before cone 33 in all cases and all cones 32 were down before any of the cones 33 showed distinct deformation.

The following test cones were made up:

1. Raw dolomite, 200-mesh, plus one to three dextrin-water mixture.
2. Dolomite fired to 1100°C 200-mesh, plus dry tar.
3. Dead-burned 2–4–4M composition, 200-mesh, plus molasses.
4. Dead-burned 2–4–4M composition, 200-mesh, plus dry tar.
5. Dead-burned 6–3–6M composition, 200-mesh, plus a 5% sodium silicate solution (about 10%).
6. Dead-burned 9–0–6M composition, 200-mesh, plus dry tar.
7. Dead-burned 9-0-6M composition, 200-mesh, plus one to three dextrin-water mixture.

Results Test cones 2–4–4M plus molasses, raw dolomite plus dextrin, fired dolomite plus dextrin, 6–3–6M plus sodium silicate, 9–0–6M plus tar and 2–4–4M plus tar, remained standing at cone 38 down. These tests required about an hour, the latter part of the firing being very slow. All these test cones turned black, had sharp edges and great shrinkage. The shrinkage caused some to fall over to an angle of 45° but even these did not lose their shape to

[1] Hewitt Wilson, "An Oxy-acetylene High Temperature Furnace," *Jour. Amer. Ceram. Soc.*, **4**, 835 (1921).

a great extent. The standard cones went down naturally being neither discolored nor bloated.

The above furnace used an excessive amount of gas and since it was desired to reach even higher temperatures, a smaller one was built (Fig. 27). This furnace was 6 inches in diameter, 7 inches high with a combustion chamber $1^1/_2$ inches in diameter and 5 inches deep. The other parts were proportionately smaller with the exception of the cylindrical pedestal on which the cones were placed. The oxyacetylene welding torches used in the large furnace were again used in this small one.

In this latter furnace, the following tests were made at cone 40 down; 6–3–6M plus sodium silicate, 9–0–6M plus one to three dextrin-water mixture and 2–4–4M plus molasses, did not show signs of fusion, having sharp edges and remaining straight with the exception of 9–0–6M which was slightly bent during the early part of the firing. This is believed to be due to shrinkage and was also noted by Robson and Withrow, who attributed it to the formation of a sufficient amount of eutectic or low melting mixture of fluxes present, to take enough dolomite into solution to cause the small tip at the top to lose shape and start bending, but the small amount of flux was presumed to be insufficiently active to cause the entire mass of dolomite to deform.

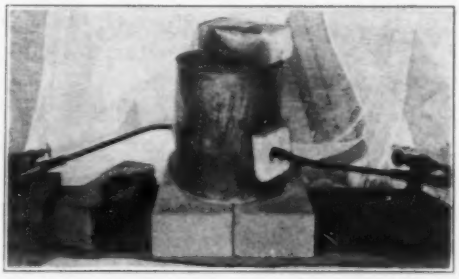


FIG. 27.—Oxyacetylene furnace.

To clear up the reason for the phenomena, just noted, the following microscopic investigation was carried out: cones 6–3–6M, 9–0–6M and 2–4–4M fired to standard cones 20, 28, 30, 38 and 42, were ground to pass 100-mesh screen and then examined under the microscope. 9–0–6M composition shows a distinctly red color, probably due to the high percentage of iron in the flux. It also shows a rapid increase in the amount of isotropic material as the temperature is increased. Since glass is isotropic and most minerals are anisotropic, this may be considered as showing that the fusion is taking place progressively as the temperature increases. 6–3–6M and 2–4–4M compositions do not show this to as pronounced a degree as does 9–0–6M composition.

In heating cones of 9–0–6M composition, it was noted that at comparatively low temperatures, cones 20–26, the cones took about a 2 o'clock position above which no further deformation could be detected. If this deformation was due to a period of glass formation followed by a reformation of minerals, it is likely that the stage of maximum iso-

tropic material would correspond with that of the 2 o'clock position of the cone. Since this is not the case, it is likely that the deformation is due to some other cause, probably due to excessive shrinkage at that particular time. It must, however, be borne in mind that some minerals are isotropic and if such were formed here, the above conclusions would not be correct.

In 9–0–6M composition at cone 42, the material under the microscope has the appearance of many round globules set in a darker matrix. It is suspected that these globules may be crystals going into solution in the matrix which is isotropic. The globules are anisotropic. This would explain the round globules since in solution the corners of the crystal would likely be dissolved first, while if crystals were coming out of the flux, they would have sharp corners. This tends to support the above conclusion that the cessation of deformation is not due to a reformation of crystals since such cannot be detected here.

Results of Cone Fusion Tests

1. The following test cones, 2–4–4M plus molasses, raw dolomite plus dextrin, fired dolomite plus tar, 6–3–6M plus sodium silicate, 9–0–6M plus tar and 2–4–4M plus tar, did not go down when heated to standard cone 38 down in an oxidizing atmosphere.

2. The following test cones, 6–3–6M plus sodium silicate, 9–0–6M plus dextrin and 2–4–4M plus molasses, did not go down at standard cone 40 down in an oxidizing atmosphere.

3. Cone 9–0–6M took about a 2 o'clock position at cones 20–26 and on further heating showed no greater deformation. This is probably due to excessive shrinkage which warps the cone in the early part of the firing.

Spalling and Load Tests

Spalling test on bricks S6–3–6M and D9–0–6M were run. Parallel tests were made on chrome and magnesia brick which had been previously reheated to cone 20 down. The kiln was then heated slowly to a temperature of 1350°C and kept constant at that temperature for one hour. The test brick were then drawn from the wicket and placed on the floor where they were exposed to room temperature. The dolomite brick and the magnesite brick cracked badly for about one-half of their length but the chrome brick did not show any visible change.

It may thus be concluded that dolomite brick like magnesite brick are very susceptible to temperature change and must not be used where exposed to rapid cooling or heating.

The load test was carried out in the usual way using standard brick.

In the furnace used the loading device was in duplicate so that two bricks could be tested at once.

In the tests on dolomite bricks D9–0–6M and S6–3–6M chrome brick was used beneath and above the dolomite brick to prevent fluxing. The tests were made by heating the furnace very slowly with the brick in place to a temperature of about 800°C when the pressure of 25 pounds per square inch was applied and held constant as the temperature slowly rose to 1350°C. (This heating up period consumed 6 hours, $2^1/_2$ hours being required between 800°C and 1350°C.) The brick were kept under the load of 25 pounds per square inch at 1350°C for one hour and then allowed to cool slowly. The ultimate crushing strength could not be determined as a higher temperature could not be attained. On removal from the furnace the brick were measured and the percentage linear contraction calculated.

Results

Brick D9–0–6M shows a linear contraction of 3% and brick S6–3–6M shows a linear contraction of 1.9%. The brick showed no distortion or cracking appearing to have undergone no appreciable change.

This test shows that dolomite bricks D9–0–6M and S6–3–6M are both fairly satisfactory from the standpoint of resistance to load while at elevated temperatures.

Summary and General Conclusions

The conclusions of the various phases of this work may be summarized as follows:

(1) A dead-burning temperature of cone 20 for compositions 9–0–6M (9% Fe_2O_3–0% Al_2O_3–6% SiO_2–85% dolomite 200-mesh), 6–3–6M (6% Fe_2O_3–3% Al_2O_3–6% SiO_2–85% dolomite 200-mesh) and 2–4–4M (2% Fe_2O_3–4% Al_2O_3–4% SiO_2–90% dolomite) is preferable to lower temperatures in that the material is thereby more completely shrunk and can be more easily bonded into brick using aqueous binders.

(2) The use of 2–4–4M composition plus molasses as a binder is unsatisfactory due to the squatting of the brick. This was shown to be inherent in the brick material and not due to a migration of the flux or a softening of the molasses.

(3) Good dolomite brick may be made by calcining 9–0–6M and 6–3–6M composition to cone 20 grinding to pass 20-mesh and making up into brick as follows:

(*a*) 9–0–6M composition plus 13% of a one to three dextrin-water mixture pressed into a brick by hand, dried at room temperatures and fired to cone 18 down.

(*b*) 6–3–6M composition plus 12% of a 5% solution of sodium silicate pressed into a brick at 500 pounds per square inch, dried under room conditions and fired to cone 16 down.

(4) Brick made as described under (3) are hard, firm and well shaped showing little squatting and no cracking.

(5) Some of the properties of these brick may be summarized as follows:

	D9–0–6M	S6–3–6M
Calcination temperature	Cone 20	Cone 20
Binder	Dextrin	Sodium silicate
Firing temperature	Cone 18	Cone 16
Linear shrinkage	7%	9%
Porosity	15.15%	20.33%
Bulk sp. gr.	2.83	2.66

(6) The cone fusion temperatures of the calcines 9–0–6M, 6–3–6M and 2–4–4M are above cone 40 down (2010°C).

(7) In the load test brick D9–0–6M shows a compression of 3.0% and S6–3–6M a compression of 1.9% when exposed to a slowly increasing temperature from 800°C to 1350°C and held one hour at 1350°C under 25 pounds per square inch pressure.

(8) Brick S6–3–6M and brick D9–0–6M when heated on the end face to 1350°C for one hour, like magnesia brick spall badly on exposure to room temperature. This shows that dolomite brick cannot be subjected to sudden temperature change without spalling.

(9) In a study of binders such as molasses, dextrin, sodium silicate, bindex, linseed oil, water, carbonated water, tar and epsom salts, it is concluded that the binders used as under (3) are most satisfactory. Although some success was had with the other binders they are deemed to be of little value for binding calcined dolomite.

(10) The use of talc as a flux is of little value as it does not permanently dead-burn the dolomite. It was also concluded after a careful study that less than the amount of flux used in the above calcines is not satisfactory.

(11) The calcined dolomite compositions studied flux violently with silica and fire brick at cone 16 down but can be safely used in contact with magnesite or chrome brick.

(12) The finer the calcined material is ground, the greater is its tendency to take up weight on exposure to the atmosphere. This is likely due to an increased tendency to slake caused by the greater surface exposed. It is thus evident that this property must not be neglected in the manufacture of brick.

(13) This report shows that dolomite brick of very desirable properties may be made on a laboratory scale and show promise for future development.

(14) The effect of grain size and pressure upon the properties of the brick was realized to be of importance and will be taken up in subsequent studies.

U. S. Bureau of Mines
Ceramic Experiment Station
and the
Department of Chemical Engineering
The Ohio State University

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

ROSS C. PURDY, Editor
EMILY C. VAN SCHOICK, Asst. Editor

ABSTRACTORS: OLAF ANDERSEN, ROBERT J. ANDERSON, A. A. AYARS, C. E. BALES, E. N. BUNTING, W. M. CLARK, S. S. COLE, R. R. DANIELSON, F. C. FLINT, A. F. GORTON, PERRY D. HELSER, C. J. HUDSON, W. R. KERR, S. KONDO, A. H. KUECHLER, R. D. LEITCH, J. T. LITTLETON JR., M. E. MANSON, T. N. MCVAY, R. J. MONTGOMERY, LOUIS NAVIAS, O. P. R. OGILVIE, C. W. OWINGS, C. W. PARMELEE, J. G. PHILLIPS, W. E. RICH, W. SCHMIDT, H. G. SCHURECHT, D. E. SHARP, H. F. STALEY, H. H. STEPHENSON, E. J. TE PAS, F. A. WHITAKER

Vol. 4 **March, 1925** **No. 3**

Author Index[1] to Ceramic Abstracts for March

AUTHOR	PAGE
A. J. M.	94
Akerlow, C. W.	68
Alexander, J.	64
Allen, F. B.	93
Amsler, W. O.	70
Arnulf, A.	82
Aupperle, J. A., and Brooks, H.	61
Bales, C. E.	77
Barkley, J. F.	85
Bigot, F.	79
Bogitch, B.	78, 91
Borelius, G., and Johansson, C. H.	82
Bradfield, R.	90
Breskin, C. A.	74
Brian, G.	94
Brown, F. W.	52
Buckman, H. H., and Pritchard, G. A.	78
Buttonfield, C. C.	52
Chapman, W. B.	91
Congdon, L. A., and Rosso, J. M.	89
Conzelman, J. W.	84
Dahl, M. F.	82
Davis, F. W., and Bole, G. A.	77
Davis, J. D.	83
De Gallaix, A.	74
De Groote, P.	85
Deussing, P.	95
de Waele, A.	91
Dressler, P. d'H.	87
Dufour, R.	84
English, S.	63
Evans, E. V.	86
Fry, A. T.	84
Fuwa, K.	64, 65, 66
Gaubert, P.	92
Gosreau, R. C.	77
Goutal, E.	93
Greenfield, G. C.	89
Greenwood, G. W.	94
Hansen, J. E.	62
Hill, C. W.	79
Hinckley, A. T.	94
Honda, K., and Takahashi, K.	91
Huet, O.	55
Johnson, H. V.	74
Jones, H. A., and Taylor, H. S.	92
Joseph, A. F., and Hancock, J. S.	92
Kishimoto, [illegible]	93
Kishimoto, K., and Ueki, S.	58
Koering, E. W.	69
Koppel, I.	89
Kudlich, R.	85
Kühl, H.	69
Ladd, J. B.	62
Lawler, E. W.	83
Le Chatelier, H.	70
Lindhard, P. T.	58
Ludwig, N. U.	86
Macdermott, J. B., and McLaren, D. A.	78
Maguet, M.	58
Marchal, Mlle. G.	58
Soc. Internationale Marmorit	58
Matignon, C.	78, 90
Matsubara, T.	88
Miller, W. T. W.	83
Minton, L. R. H.	82
Morey, G. W., and Bowen, N. L.	89
Moureu, C., Dufraisse C., and Landrieu, P.	90
Noaillon, E.	95
Noble, R. E.	84
Norton, C. L.	78
Nugey, A. L.	94
O'Day, M.	90
Oppermann, F. M.	70
Parsons, A. B.	87
Parsons, C. E.	70, 93
Pascal, P.	92
Pearce, J. G.	94
Penfield, R. C.	74
Pilkington Bros., and LeMare, E. B.	71
Pilkington Bros., and Railton, D.	71
Plant, H. J.	80
Portevin, A.	91
Power, H. R.	52
Rebbeck, J. W., and Ferguson, J. B.	68
Rees, W. J.	64
Rideal, E.	89
Robertson, H. M.	86
Rohn, W.	88
Satoh, S.	75
Schartzbach, O.	68
Schieldrop, B.	69
Schwarz, M. v.	70
Scott, V. H.	64
Searle, A. B.	73

[1] The abbreviation (*C. A.*) at the end of an abstract indicates that the abstract was secured from the editor of *Chemical Abstracts* by coöperative agreement.

Author Index to Ceramic Abstracts for March (*Continued*)

Author	Page
Shearer, W. L.	80
Sherwood, R. F.	82
Shimomura, S.	59
Shively, R. R.	62, 63
Silverman, A.	95
Smith, G. O.	68
Smith, M. A., and Blaze, J.	70
Smith, R. C.	92
Staley, H. F.	59, 60, 61
Stebbins, A. H.	84
Sweeney, O. R., and Quam, G. N.	82
Sugie, J., and Hatayama, O.	88
Takahashi, S.	67
Teitsworth, C. S.	78
Thiene	69
Tool, A. Q., and Eichlin, C. G.	69
Treischel, C. C.	81
Treuheit, L.	95
Tsountas, M. C.	54
Turner, W. E. S.	64
Twitchell, W. W.	87
Uneno, Z.	75
Walker, E. E.	87
Wartenberg, H. v.	77
Weigel, W. M.	52, 70, 83, 94
Wikle, H. H.	72
Wilhelmy, O.	69
Williamson, F. S.	89
Wilputte, L.	87
Wilson, S. S.	59
Wöhler, L., and Metz, L.	89

Abrasives

Abrasive manufacture in England. Anon. *Abrasive Ind.*, **5** [11], 275–6 (1924).—This article describes the modern type of automatic abrasive paper coating machine, which has replaced the antiquated hand method, at the plant of W. J. Davies & Sons, Ltd., Bermondsey, London. There are illus. showing the 2 methods. The machinery is of special design, whereas the drying racks on which the coated web is festooned automatically, are the same as those used in the drying of wall paper. An abrasive is described made from a slag produced in making metallic chromium through an endothermic reaction. It runs high in alumina and is considered an excellent abrasive. A mass of crystals is shown. P. D. H.

Outline wheel salvage methods. F. W. Brown. *Abrasive Ind.*, **5** [12], 293–4 (1924).—The article illustrates and describes the methods followed in salvaging wheels at the plant of the Continental Motors Corp., Muskegon, Mich. The wheels are sided in an engine lathe with mechanical dressing tools at a working speed of 280 r.p.m. on wheels from 12 to 24″ in diam. The wheel edges are trued on a heavy grinding stand at a peripheral speed of 2000 ft. per min. on 12 to 24″ diam. wheels. From $1200 to $1500 worth of salvaged wheels are put back into stock each month. A company having a monthly wheel consumption of $1000 worth or over should consider a wheel salvage department. P. D. H.

Preparing garnet abrasives. Henry R. Power. *Eng. and Min. Jour.-Press*, **118** [14], 532(1924).—The manuf. of garnet abrasives is described. The size of the garnet used is 5-mesh and finer. This is run through rolls which crack it to 20-mesh and finer. Then it is thoroughly graded and the gangue is removed. The next operation is that of accurately sizing over standard screens. Sizes range from 20-mesh down to through 220-mesh. In the coating process, machinery, well known in the textile trade, is used. From a large roll the paper or cloth passes continuously over a roll dipped in a glue solution which coats one side with a thin layer of glue; thence it goes under a hopper containing the graded garnet which falls in a shower on the glued side. To anchor the garnet more securely a second coat of glue is run over it. Uses of garnet paper and cloth have been mostly in the wood working industries. Only the highest quality of material can be used in making surface abrasives. Garnet abrasive paper and cloth are modern abrasive tools of highest quality. A. H. K.

Preparing sands for blasting uses. W. M. Weigel. *Abrasive Ind.*, **5** [12], 309–10 (1924). P. D. H.

Manufacture of organic bond wheels. Anon. *Abrasive Ind.*, **5** [12], 316(1924). P. D. H.

PATENT

Abrasive mixture for fitting pistons in cylinders. C. C. BUTTONFIELD. U. S. 1,463,501, July 31. Alundum 27, $PbCO_3$ 32 and graphite 41 parts. U. S. 1,463,502 specifies a mixt. of $PbCO_3$ with about three times as much SiO_2, of which 5% is 40 mesh, 5% 60 mesh, 15% 80 mesh, 50% 100 mesh and 25% 200 mesh. A small amt. of graphite also may be added to this mixt. (*C. A.*)

Art

A note on Greek design—recent accession of pottery. ANON. *Bulletin, Cleveland Museum of Art*, December (1924).—When certain North European tribes came across the mountains into Greece a dozen or more centuries B. C. they brought with them geometric design of lines and spots. In Greece these people found the art of Semetic Cretans, a naturalistic art of representation, combined with ornament of scrolls agreeably filling the space. Others came, forcing the earlier tribes out of Greece to the Islands eastward and to the coast of Asia. These eastward migrants so absorbed the Semetic art that their own reflects it almost totally, while those who remained in Greece absorbed it as an element of new art, reconciling representation with their own instinct for design. Both types of art are shown in the Greek pottery recently acquired by the Museum. A rare Ionic pitcher shows the Eastern Greek playing with Semetic design. The pitcher of the 6th century B. C. is black with a luster like that of the Athenian ware. On one side is a red panel ornamented with a fine cock, lotus flowers filling in the open spaces. The compn. is decorative in the sense of the decoration of Assyrian and Cretan design and has the Semetic characters of arranged naturalism. Three Corinthian pieces of the 6th century B. C., two spherical jars and a drinking cup, are beautiful examples of Greek draftsmanship, mothered by European rhythm and fathered by Semetic imagery, with a beautiful surface pattern like an Oriental embroidery. The charm is in the lovely sensibility of elastic line and moving spot, but no design of the Semetic East can compare with it in utility. The strange animals are drawn with lines of alternate tension and relaxation, in actual rhythm. The rosettes scattered on the field float into every opening space. Such drawing is not a matter of correctness, it is the result of mental images released through the flowing hand of the artist. It is found later in Persian art, in the art of the Renaissance masters of Florence, and of independent origin, in Chinese art. A handsome great amphora ($25^1/_8$″ in height) in a style usually called Italo-Corinthian shows that even the Greek provinces in Italy had this Hellenic union of vital representation with elastic design, though the craftsmanship was usually less elegant. Of a light yellowish clay, it is richly colored with reds varying from terra cotta to purplish. Its band of Oriental beasts are drawn with the self-reliant line of the Greek. A 2nd Italian example of Greek works is a bell krater from Apulia, of the 4th century B. C. (12″ high). On one side are 2 youths with thyrsus and staff, on the other, a seated Aphrodite with her son Eros holding her girdle; these are of transplanted Athenian Art. A little careless in execution, like most Apulian pottery, it still shows Greek feeling for life expressed in moving line. An Athenian column krater, is of the excellent red-figured ware of the 5th century B. C. On one side is a panel of 3 youths standing in conversation; on the other, 2 satyrs are pursuing 2 maenads. The painting is not careful; but its freedom from discipline helps one to feel the essential character of Athenian drawing. It is a character of form that was felt whether or not it was known, a form expressed always in moving, dynamic line, perfectly free within the confines of its panel. That quality more than any other is the essential of the Hellenic art which has been such a source of strength to the later art of both Europe and Asia. A. A. A.

Ceramic color notes in our Colonial homes. R. T. H. H. *Bull. Metropolitan Museum of Arts*, July, pp. 173–8(1924).—Our early inventories and newspaper advertisements evidence the fact that that same recognition of the decorative value of pottery and porcelain which Lord Macaulay, in his "History of England," attributed to the advent of William and Mary, existed here from our early days along with the appreciation of beautiful textiles, furniture and plate. There is no question but that wooden dishes furnished as a rule our 17th-century New England dining tables. There was also a certain amount of pewter and silver in the homes of the well-to-do and inventories of the period indicate that the white, and blue and white faience made in Holland and England was used in our extreme Northern colonies. In New York, however, there is everything to indicate that many of those K'ang-hsi porcelains brought into Holland by the Dutch East India Company were re-exported here and made important color notes in the rooms of many an early New York home. Some inventories indicated that the holding of a hundred pieces of pottery and porcelain was not uncommon. In New England there were early oriental porcelains also. As the 18th century advanced, and the interest in the potter's art greatly increased in England, quantities of crude earthenware of Staffordshire found a market on this side of the water. Advertisements appeared in the Boston papers and about 1723 came beautiful white salt-glazed ware "tea setts" of white, "blew" and Japann'd glass with also all sorts of white, brown and "blew" stone and fine earthenware, as well as all sorts of Dutch, stone and delf ware. Color was commencing to play an important part. In the second half of the 18th century, salt glazed wares, both white and enameled, came into New York, as well as English brown china tea-pots, flint-ware and earthenware from Bristol. An advertisement (New York 1771) included copper-plated Queen's ware, plain Queen's ware, white stoneware, colly-flower ware, tortoise shell and agate ware and delf ware. While most of the "table setts" so frequently advertised were from the Orient, we have every evidence that the fine English porcelain, tea and dinner sets made at Worcester, Derby, Bow, etc., came over in large quantities. The Museum is most fortunate in possessing a fine collection of English porcelains, the bequest of John L. Cadwalader. "Burnt china," a term used in American inventories to differentiate between porcelain and earthenware, appeared among the offerings of our pottery importers from 1765 on, as well as "a great variety of images for mantle pieces and chests of drawers" (1765), "complete sets of image china" (1767), "burnt image china" (1770), "The greatest variety of ornamental china, sets of figures, pairs and jars" (1770), "A great variety of the neatest ornamental china ever imported, consisting of small cups, figures, pairs, setts, groups, beeckers and jars" (1771). Such documentary evidence and the knowledge of the existence of a few heirlooms from Colonial days warrant the Museum in using examples of these superb English porcelains on tables, chests, mantelpieces, and wall brackets in the "Marmion" and "Powell" rooms, both of which were built toward the end of the Colonial era. Of the various pieces of white stoneware that it is proposed to display in the American wing, the "Porto-Bello" ware must necessarily have the greatest interest to Americans in the intimate relation of the story it tells, to the naming of Mount Vernon, memorializing as it does the capture of Porto Bello, the great Spanish stronghold on the Isthmus of Panama. No victory of the English Arms from the defeat of the Spanish Armada to the achievements of Nelson awakened in England the enthusiasm caused by this event. The idea of making this Porto Bello ware is ascribed to Astbury; it was advertised here for sale as late as 1765. The shapely and quaintly modeled embossments on the bowl illustrated, depict the semi-circular harbor defended by the lofty castles, Gloria and St. Jeronimo, a land battery on a promontory in the harbor beyond which the Spanish gunboats are in hiding. The six ships under sail are shown as well as the figure of the hero. On the other side is the legend:

"The British Glory Revivéd
By Admiral Vernon. He Took
Porto Bello With Six Ships Only
Nov ye 22, 1739. A. A. A.

Properties of cements intermediate in composition between Portland cement and fused cement. OSCAR HUET. *Rev. Mat. Constr. Trav. Pub.*, **181**, 253–6; **182**, 288–91 (1924).—In Fig. 3 are indicated the 30 compns. including Port. cement on the left and

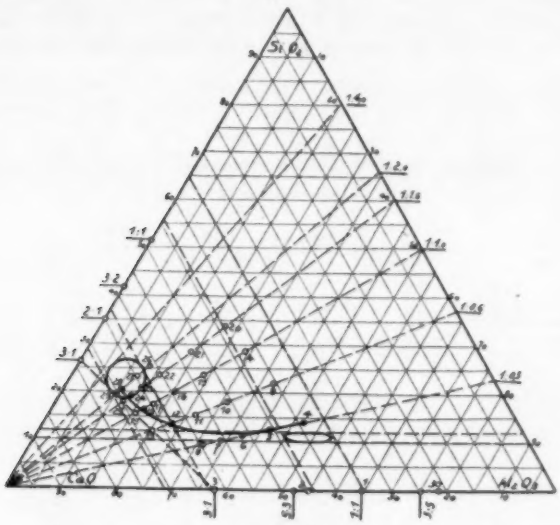


FIG. 3.

fused cement on the right that were made and studied. The raw mats. consisted of marble, sand and hydrated alumina with chem. compns. as follows:

	Marble	Sand	Hydrated alumina
SiO_2	2.53%	98.83%	0.24%
R_2O_3	0.95	1.40	66.00
CaO	52.05	....	.....
MgO	1.77	....	.....
Ign. loss	42.46	....	33.52
	99.76	100.23	99.76

The fusions were made in an elec. fur. with a carbon tube resistor and container, and were allowed to cool slowly with the fur. Thin sections for microscopic examn. were made of nearly all compns. The fur. products were also pulverized and subjected to tests for time of set, constancy of vol. by boiling in water, and tensile strength. *Optical study.* 23 photomicrographs are given to illustrate the cryst. structures studied. The cryst. compds. identified in the petrographic study are indicated as (+) in Table I, whereas the cryst. compds. required to be present under equil. conditions according to the work of RANKIN on the ternary system, are marked with or without parentheses.

Short general descriptions of the cryst. compds. found in the products are given in connection with the photomicrographs. *Physical properties.* The test pieces made of a 1:3 mortar were subjected to moist air for the first 24 hrs. and then submerged under water until tested. Table II gives the results. *Conclusions.* In Table II the compns. are divided into 6 groups. The individual compns. giving the highest tensile strength in each group II–VI after 28 days, are joined together, as indicated in Fig. 3. The curve shows not only the compns. between Port. cement and fused cement having the greatest strength but also indicates the limit of constancy of vol. in the field investigated. The curve passing from right to left approaches more and more the line joining $3CaO.SiO_2$ and $3CaO.Al_2O_3$. It is also the graphical expression of the increase of the mol. ratios of bases to acids for the compns. having the highest lime content as well as the

TABLE I

Number	CaO Al_2O_3	$5CaO$ $3Al_2O_3$	CaO	$3CaO$ Al_2O_3	$2CaO$ SiO_2 Al_2O_3	$2CaO$ SiO_2	$3CaO$ SiO_2	Al_2O_3	$3CaO$ $5Al_2O$
1	(+)								
2	(+)	(+)							
3				(+)					
4	(+)				(+)				
6	(+)	(+)				(+)			
7		+		+		+			
8				(+)		+	(+)		
9					(+)				
11		+		+		+			
12				(+)		+	(+)		
13			(+)	(+)			(+)		
16		+		+		(+)			
17				+		(+)	(+)		
18			(+)	(+)			(+)		
19			(+)	(+)			(+)		
22		+		+		(+)			
24				(+)		+	(+)		
25			(+)	(+)			(+)		
26		+		+		(+)			
27				(+)		(+)	(+)		
29			(+)	(+)			(+)		
30								+	(+)

property of constancy of vol., for each of the groups in Table II. Further this degree of basicity increases with the silica index, from group to group. *Rapidity of setting.* The setting of any aluminate contg. less lime than in the compd. $3CaO.Al_2O_3$ is accelerated by the presence of hydrated lime obtained from the simultaneous hydration of silicates of lime in the cement. The aluminates during their hydration set free hydrated alumina, which combines with the hydrated lime to form hydrated tricalcium aluminate, causing the rapid setting of the cement. The aluminates giving the latter effect are $5CaO.3Al_2O_3$ and $CaO.Al_2O_3$. The theory is confirmed by the manner of hydration of Nos. 6, 7, 11, 16 and 22 which have the most rapid setting of all compns. From these considerations one might be led to believe that a fused cement having the constitutional formula proposed by BIED $x(2CaO.SiO_2) + y(Al_2O_3.CaO)$, would be necessarily quick setting. As a matter of fact the fused cements set normally, the reason being that the aluminates in the compn. predominate to the extent of $y > 2x$. While the hydration

TABLE II

No.	Group	Composition	Mol. ratio bases/acids	SiO_2 Per cent	R_2O_3 Per cent	CaO Per cent	Silica index	Index of hydraulicity	Tensile strength, kgs. per sq. cm. 2d.	7d.	28d.	Constancy of volume in boiling water
1		Al_2O_3. CaO		—	64.57	35.43	—	0.55	26.5	34.0	39.5	Constant
2	I	2 Al_2O_3. 3 CaO		—	54.85	45.14	—	0.82	37.5	44.5	44.0	"
3		Al_2O_3. 3 CaO		—	37.80	62.20	—	1.65	7.5	6.5	6.5	Swelled up
4		2 $Al_2O_3.SiO_2$. 3 CaO		13.93	47.21	38.86	0.3	0.64	11.5	16.0	23.0	Constant
5		— 4 CaO	(No. 6)	12.33	41.80	45.87	"	0.85	22.5	22.0	23.0	"
6	II	— 5 CaO	5:3 =	11.06	37.50	51.43	"	1.06	29.5	19.0	19.0	"
7		— 6 CaO	1.6:1.0	10.03	34.00	55.96	"	1.27	5.0	5.0	5.0	Soft
8		— 7 CaO		9.17	31.10	59.72	"	1.48	—	—	—	Poor
9		$Al_2O_3.SiO_2$. 2 CaO		21.95	37.21	40.83	0.6	0.69	—	—	—	Not tested
10		— 3 CaO	(No. 12)	18.23	30.90	50.86	"	1.04	8.5	12.0	16.0	Constant
11	III	— 4 CaO	5:2 =	15.59	26.42	57.99	"	1.38	8.0	12.0	17.0	"
12		— 5 CaO	2.5:1.0	13.62	23.08	63.30	"	1.72	8.5	12.5	19.0	"
13		— 6 CaO		12.09	20.49	67.43	"	2.07	5.0	7.0	8.0	Soft
14		3 Al_2O_3.5 SiO_2. 8 CaO	(No. 18)	28.53	29.01	42.45	1.0	0.75	—	—	1.5	Not tested
15		— 12 CaO		23.54	23.94	52.52	"	1.11	8.5[1]	11.0	14.0	Constant
16	IV	— 16 CaO	22:8 =	20.03	20.37	59.60	"	1.48	10.0	12.0	16.0	"
17		— 20 CaO	2.7:1.0	17.43	17.73	64.84	"	1.84	11.0	12.5	18.5	"
18		— 22 CaO		16.37	16.65	66.98	"	2.03	12.5	13.5	19.5	"
19		— 24 CaO		15.43	15.69	68.87	"	2.20	4.0	7.0	11.0	Soft
20		2 Al_2O_3.5 SiO_2. 7 CaO		33.56	22.75	43.69	1.5	0.77	—	—	2.0	Not tested
21		— 10 CaO	(No. 24)	28.27	19.16	52.57	"	1.11	—	1.0	15.0	Soft
22	V	— 14 CaO	19:7 =	23.36	15.83	60.81	"	1.55	10.0	11.5	16.0	Constant
23		— 17 CaO	2.7:1.0	20.66	14.01	65.33	"	1.88	11.5	12.5	17.0	"
24		— 19 CaO		19.18	13.01	67.80	"	2.10	16.5	17.5	20.0	"
25		— 21 CaO		17.91	12.14	69.94	"	2.32	4.5	8.5	13.0	Soft
26		3 Al_2O_3.10SiO_2.26 CaO		25.48	12.95	61.58	2.0	1.60	2.0	2.5	4.0	Not tested
27	VI	— 30 CaO	(No. 29)	23.26	11.83	64.90	"	1.85	11.0	16.0	20.0	Constant
28		— 36 CaO	39:13 =	20.59	10.46	68.94	"	2.22	13.0	18.0	22.5	"
29		— 39 CaO	3.0:1.0	19.48	9.90	70.62	"	2.40	17.5	19.0	23.5	Cracked
30	I	2 Al_2O_3. CaO		—	78.47	21.52	—	0.27	Not tested			Not tested

[1] 3 d.

takes place thus: $y(Al_2O_3.CaO)$ + aq. = $v/3(Al_2O_3.3CaO$ aq.) + $2v/3(Al_2(OH)_6)$, the hydrated alumina does not obtain rapidly enough, nor in sufficient quantity for, the hydrated lime (from the silicate) to form the hydrated $3CaO.Al_2O_3$, capable of provoking rapid setting. The setting of a fused cement can be increased by supplying the deficient quantity of silicates of lime by the addition of Port. cement. L. N.

Study on Sorel's cement. KIYONOBU KISHIMOTO AND SHOJI UEKI. (The Osaka Indus. Lab.). *Bull.* **5** [2], 26(1924).—The paper relates to the manuf. of Sorel's cement with Manchurian magnesite and crude magnesium chloride. The magnesite, calcined for 8 hrs. at 800°C, contd. MgO 89.2, CaO 3.5, Al_2O_3 and Fe_2O_3 1.45, SiO_2 3.24 and ig. loss 1.45. Dried crude magnesium chloride was composed of $MgCl_2$ 91.1, alkali chlorides 8.1 and $CaSO_4$ 0.5. I. *Temp. of calcining magnesite.* Results of calcining the magnesite, about 3 cm. large, at various temps. are: (1) Magnesia calcined at 600° or 700°C causes contraction in setting, while that calcined at 1000° or 1100°C expands; (2) Tensile strength of the cement after 1 week is greater than that after 4 weeks, when the magnesite has been calcined at 600° or 700°C; the relation is reversed, when it has been htd. at 800°C or higher; (3) Moreover, the strongest cement is obtained when the mineral is calcined at 800° or 900°C; (4) Incomplete dissociation of the magnesite causes, sometimes, crumbling of the briquettes. II. *Concentration of magnesium chloride soln.* Expts. with the solns. of 17–34°Bé have given the result that the stronger the soln. the stronger the cement. Generally speaking, an excess of the soln. reduces tensile strength of the cement briquettes. III. *Mixing of quartz sand.* Roughly speaking, tensile strength of the cement-sand mortar is inversely proportional to the content of sand. IV. *Prevention of weathering and sweating.* Weathering or growth of white minute crystals and sweating on the surface of the cement products are due chiefly to the presence of free magnesium chloride. These defects can be prevented by dipping the set products in a soln. of sodium silicate (5–22°Bé), pot. silicate, hydrogen ammonium fluoride or pot. cyanide. S. K.

Action of silica and alumina on calcium sulfate. MLLE. GERMAINE MARCHAL. *Compt. rend.*, **177**, 1300–2(1923).—The possibility of recovering SO_2 makes it desirable to study quantitatively the substitution of $CaSO_4$ for $CaCO_3$ in the manuf. of cements. (*a*) Pure $CaSO_4$ and pure SiO_2 (from $SiCl_4$) and (*b*) pure $CaSO_4$ and pure Al_2O_3 were heated in a porcelain tube fur. With *a* the reaction begins at 870°, with *b* at 940–50°. Tables are given showing the equil. pressures of the 2 systems at different temps. up to 1280°. Extrapolation indicates that in *a* atm. pressure is reached at 1273°, and in *b* at 1363°. The difference between these 2 temps. is in keeping with the difference between the heats of formation of Ca silicate and Ca aluminate. (*C. A.*)

PATENTS

Rotary cooler for cement clinkers, etc. P. T. LINDHARD. U. S. 1,503,193, July 29. (*C. A.*)

Granulating slag. M. MAGUET. U. S. 1,502,793, July 29. A jet of highly heated basic calcareous and sulfurous slag as it issues from a blast furnace is divided into small drops by the action of a low pressure air blast by which the temp. of the slag is initially lowered to about 1300°. The slag thus loses part of its fluidity without solidification and the drops are then introduced directly into H_2O to effect hardening and shattering into a large number of smaller fragments which constitute an artificial pozzuolanic sand suitable for use in the manuf. of *slag cement.* (*C. A.*)

Magnesian artificial stone. SOC. INTERNATIONALE MARMORIT. Brit. 214,947, April 23, 1923. A material contg. over 42% MgO is calcined at a temp. above 1600°, ground and mixed with powdered quicklime in the proportion of MgO 4.5 and CaO 1 part. A 20–32° Bé. $MgCl_2$ soln. is then added, fine sand or $CaCO_3$ and coloring substances are also added and the mass is molded and retained at a temp. above 20° for 48 hrs. (*C. A.*)

Tiles and similar articles from asbestos and cement. S. S. WILSON. U. S. 1,503,409, July 29. In forming slabs, sheets, tiles and the like from a mixt. of asbestos, cement and H_2O, the mixt. is spread upon a slab of plaster of Paris in order to remove moisture. (*C. A.*)

Enamels

Enameled watch-dial. SHIZUO SHIMOMURA. *J. Jap. Cer. Assn.*, **32** [375], 93–100 (1924).—I. *Relation between ground-coat and cover-coat frits.* (1) Coeff. of expansion. Cubical coeff. of expansion must be about 300×10^{-7} and 280×10^{-7} for ground-coat and cover-coat frits resp. (2) M. p. The most desirable m. ps. are about 570° and 800°C for ground-coat and cover-coat frits resp. II. *Raw materials.* Clay, feldspar, boric acid and borax are not used for cover-coat frit. Arsenious acid is the only opacifier which gives excellent results. III. *Expts. on the frits.* Series 1. No. 1 in the table, prepd. after an excellent Swiss cover-coat enamel gave a transparent glass which could not be opacified by further increases of arsenious acid. Reduction of alkalis made the glass opaque, though it became too refrac. By increasing red lead, light opaque ones were obtained. Then they were improved further by adding more arsenious acid, though it made the enamels too brittle. This defect was overcome by changing the amts. and ratio of the alkalis. Thus a pretty good enamel, No. 11, was obtained.

TABLE I. COVER-COAT ENAMELS

	Quartzite	Red lead	Arsenious acid	Potassium carbonate	Sodium carbonate	Niter
No. 1	100	120	13	36	45	5
No. 11	100	170	16	22	3	4
No. 14	100	163	17	25	3	4
No. 17	100	160	19	24	5	4

Expts. on the ground-coat frits for No. 11 are described. A batch, composed of quartzite 100, red lead 140, feldspar 70, slaked lime 25, antimony oxide 15, sodium carbonate 50 and niter 10, gave a satisfactory result. The use of fluorspar was abandoned, as it caused bubbling. Introduction of boric acid seems to make the enamels too hard. Series 2. Expts. on the further improvements of the enamel No. 11 are described. Increase of potash in the enamel No. 11 at the expense of lead oxide made it more bright and fit for charcoal pressing on account of its softness. *E. g.*, enamel No. 14 is far better than No. 11. Further decrease in lead oxide made the enamel too soft, though better result in the charcoal pressing was obtained. This defect was overcome by replacing some potash with soda. Enamel No. 17 is one of such compounds. A ground-coat frit from quartzite 100, red lead 155, feldspar 70, slaked lime 25, stannic oxide 50 (or stannic acid 25 + arsenious acid 25), sodium carbonate 52 and niter 10 was excellent for use with these cover coats. IV. *Grinding and washing of frits.* Cover-coat frits must be air-cooled and then ground to pass through No. 120 sieve. Then, they are washed with water and nitric acid. They are used as cover-coat enamel as they are. Ground-coat frits may be poured in water, other procedures being similar with above. A ground-coat enamel is made by regrinding a mixt. of a ground-coat frit and a cover-coat enamel, say in equal parts. V. *Firing.* Ground-coat was fired for 4 minutes at 750°C, while cover-coat was heated for about 15 minutes at 850°C. S. K.

Principles of enameling. II. H. F. STALEY. *The Ceramist*, **4**, 87–98(1924).—The properties, mining and prepn., function in enamels, importance of accurate chem. anal., control of feldspar. In dry coat enamels for cast iron, feldspar constitutes 30–35% of the raw enamel mixt., or 36–42 of the melted enamel. In sheet steel enamels 20–60% of feldspar is employed. In wet coat enamels for cast iron from 0–30%

feldspar is used. Excepting in a few ground coats for dry coat cast iron enamels, the feldspar is melted in the frit. The following are the factors by which the percentage amts. in the melted enamel of pure minerals must be multiplied to give the effect on the comparative figs. usually employed for controlling expansion of enamels.

Mineral (pure)	Coeff. factor for each per cent
Potash feldspar	2.87
Soda feldspar	2.70
Lime feldspar	3.18
Quartz	0.80

Variation in the rel. amts. of feldspar in any one standard commercial brand does not have a marked effect upon the coeff. of expansion, but comparatively small variation in the amt. of free quartz has a decided effect on the coeff. of expansion. The detn. of free quartz by microscopic examn. of the feldspar is accurate only to about 5% of quartz, which is not sufficiently close for such purposes. The analytical detn. of total silica is not sufficient to show the amt. of free quartz present. The only satisfactory method is a complete and careful chem. anal. The author shows that the increase of silica content above certain minimum decreases the coeff. of expansion uniformly. After a certain silica content is agreed upon the feldspar shipper should maintain the variation of the silica within 0.5% of the agreed figure otherwise chipping or crazing may follow.

C. W. P.

Principles of enameling. III. H. F. STALEY. *The Ceramist*, **4**, 167–78(1924).—*Specifications for feldspar.* The author shows by calcn. of free quartz content the nature of the difficulties which may be anticipated with small variations in the silica and the feldspar. The relative influence of potash and soda in enamel is discussed. The author considers it doubtful whether the effect of the kind of alkali present in feldspar has ordinarily any important effect on enamel compn. In purchasing feldspar it would seem advisable to specify the relative amts. of potash and soda with rather wide limits. He doubts whether the amt. of lime present in feldspar has any effect on enamels. Moreover, calcium oxide can be bought at a low price in the form of whiting, therefore in purchasing, the max. amt. of lime permissible should be specified. In general the amt. of magnesium oxide is less than 0.5% excepting in certain feldspar deposits which are not being worked at present. The action of these feldspars should be carefully studied before they are substituted. The max. amt. of magnesium permissible should be specified. The amt. of alumina present in feldspar is fixed by the per cent of potash, soda and lime. Any mat. excess is an indication either of the presence of kaolin or of poor anal. The presence of kaolin may be detd. by a mineralogist. Iron oxide may be present in amts. less than 0.5% which is permissible for feldspar used in making white enamels. It is possible that this limit may be raised to 1%. This, however, should be checked by trial. The amt. of free silica may be calculated from anal. The greatest objection to its variation is the notable effect it has upon fusibility and thermal expansion. Also, free silica can be more cheaply purchased in the form of ground quartz. Free quartz is permissible in the highest grade feldspar in amts. up to 5%. Higher percentages may be present provided the shipments do not vary. The author proposes specif. for several types of feldspars. The cone fusion test, the color on fusion, screen test, moisture content, and influence of fineness of grain are briefly discussed.

C. W. P.

Principles of enameling. IV. H. F. STALEY. *The Ceramist*, **4**, 229–36(1924).—Calcn. of percentage compns., of melted enamel by fluorides and for loss of silica assuming that the fluorides are decomposed and that fluorine volatilized as silicon fluoride.

C. W. P.

Principles of enameling. V. HOMER F. STALEY. *The Ceramist*, **4**, 351–62 (1924).—A summary of the recent work on fish-scaling as reported by Shaw, Danielson and Souder, Grainer, Sweely and Geisinger. The author reviews and analyzes their results and gives the following summary. (1) Fish-scaling in enamels on sheet metals consists of rupture of the enamel due to compressive stresses. The causes of these compressive stresses may be (*a*) higher coeff. of thermal expansion and contraction of the metal than of the enamel; (*b*) uneven cooling of the piece of ware, especially when this produces warping. (2) Whether the stresses operating will cause the enamel to rupture will depend upon the magnitude of the stresses, the form and thickness of the enamel coating, the breaking strength of the enamel, its elasticity, and its adhesion to the metal. (3) Factors effecting the difference in thermal expansion and contraction of the metal and the enamel coating are: (*a*) Compn. of the enamel batch, (*b*) degree of mtg. of the batch, (*c*) amt. and character of raw additions, (*d*) degree of firing of the enamel coating. (4) Factors effecting uneven cooling and warping are: (*a*) Thickness of the metal and enamel coating in various parts of the piece, (*b*) size and shape of the piece, (*c*) rate of cooling, (*d*) character of the metal (warping only). (5) Factors effecting the adhesion of the enamel to the metal are: (*a*) Compn. of the enamel batch, (*b*) degree of mtg. of the enamel, (*c*) amt. and character of raw additions, (*d*) degree of firing of the enamel coating, (*e*) thickness of the enamel coating. (6) Factors effecting the adhesion of the enamel to the metal are: (*a*) Compn. of the enamel, (*b*) method of prepn. and application, (*c*) degree of firing of enamel coating, (*d*) structure of metal surface, (*e*) cleanness of metal surface. C. W. P.

Principles of enameling. VI. H. F. STALEY. *The Ceramist*, **5**, 29–35(1924).—Investigation made by the author on the influence of the size of grain of feldspar leads him to conclude that enamelers cannot use 40-mesh feldspar to advantage, that there is some advantage in using 140-mesh instead of 90-mesh, and that there is no advantage in using 200-mesh. In white enamels containing lead oxide and antimony, the use of coarse grained feldspar lengthens the time of melting to such an extent that blue tints are likely to be developed. The enamel compn. used was a high grade sodium antimonate enamel. C. W. P.

Principles of enameling. VII. H. F. STALEY. *The Ceramist*, **5**, 96–104(1924).—Discussion of the derivation of the factors used in the calcn. of the coeff. of thermal expansion with special reference to recent observations by TURNER and his associates and investigators of the Bureau of Standards. The writer is of the opinion that while the factors possibly are not accurate from the standpoint of highly specialized phys. labs., nevertheless they are satisfactory as a guide in the tech. control of enamel mixts. C. W. P.

The development of sheet metal for vitreous enameling. JAS. A. AUPPERLE AND HOWARD BROOKS. *The Ceramist*, **4**, 294–303(1924).—The production and properties of Armco iron for enamel stock. It has been found desirable to keep the carbon content about 0.01%, manganese below 0.03%. The microstructure of ingot iron, mild steel, wrought iron and welded ingot and mild steel are discussed with particular reference to their use as enamel stock. C. W. P.

Enameling furnace design. ANON. *Ceram. Indus.*, **4** [1], 30–7(1925).—This article covers the advantages and disadvantages of different types of furs., the fuels used in each and the principles of successful opern. There are a number of sketches showing different types of fur. construction including the new elec. rotary continuous fur. A large amt. of enameling fur. data, resulting from questionnaires, is given in tabular form and discussed. P. D. H.

Staging a remarkable comeback with new enamel furnaces as a basis. ANON. *Ceram. Ind.*, **3** [6], 381–5(1924).—The remodeled plant of the Wolff Mfg. Corp., of

Chicago, Ill. is described. Eight double and 2 single Carboradiant fur. were built. The details of the fur. are shown and the operation described in drawings. The fuel oil is carried at 50 lbs. press. with air at $1^1/_2$ lbs. The combustion chambers are made of carborundum. The heat from the waste gases which are by-passed through a vertical tube boiler is utilized to furnish hot water for the entire htg. system of the plant.

P. D. H.

Cabinet sand blast proves popular. ANON. *Ceram. Ind.*, **3** [6], 412(1924).—The Crown Stove Co. of Chicago, Ill., has an 8 ft. humane type, direct press. sand blast cabinet of the Mott type which has a capacity of 47,000 lbs. of castings per month by using 2 men for 26 ten-hour days. The operator directs his work through celluloid panels from the outside and sometimes finds it necessary to wear goggles but never a mask.

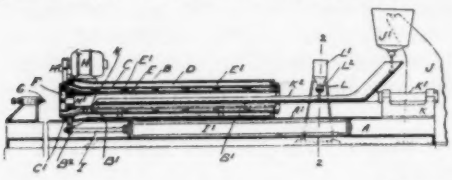
P. D. H.

Types of enamel smelters. J. E. HANSEN. *Fuels & Furnaces*, **2**, 141–4(1924).

D. F. B. (*C. A.*)

PATENTS

Method of enameling centrifugally cast pipe. JAMES B. LADD. U. S. 1,521,634, Jan. 6 1925. The method of applying enamel to the inside of centrifugally cast pipe which consists in floating the enamel on the surface of the molten metal in the container through which said metal is introduced into the rotating mold and pouring said metal and enamel simultaneously into the mold.



Glass

New jar machines increase glass plant efficiency. ANON. *Ceram. Ind.*, **3** [6], 388–9(1924).—The plant of the Ohio Glass Products Co. is described. The efficiency of the gas producer is such that 1000 lbs. of coal will make one ton of melted glass or the equivalent of a gas rate of less than 20 cts. per thousand. After the batch of raw materials is weighed, it is mixed for 3 min. and delivered to the tank into which it is fed automatically at a given rate. The tank which has a daily capacity of 60 T. is 47 ft. in length and 19 ft. in width with a fining chamber 33 ft. in length. About 48 hours are required for the raw batch to travel from the doghouse to the working chamber. The temp. in the firing chamber is 2100°F and in the mtg. chamber 2500°F. The working end of the tank is lined with cork brick which makes the use of a heavy air blast unnecessary. The machines which were invented by SAMUEL WINDER and HENRY DAUBENSPECK are described in full.

P. D. H.

Glass tank operation. ANON. *Ceram. Indus.*, **4** [1], 20–9(1925).—This is a report of an invest. in the glass field and includes the ideas of prominent glass fur. engineers and operators on tank construction and opern. There are a number of sketches showing different types of ports and of construction in general. A large amt. of glass tank data, resulting from questionnaires, is given in tabular form and discussed. There are curves showing the proper capacity at which a glass tank can be run the most economically so far as fuel and refrac. are concerned.

P. D. H.

A revolutionary development in making clear fused quartz. STAFF ABSTRACT. *The Ceramist*, **4**, 165(1924).—A description of the process recently developed by the General Electric Company.

C. W. P.

Principles of glass making. R. R. SHIVELY. *The Ceramist*, **4**, 136–42(1924).—Primary calcns. for wt. of glass produced from the batch and the percentage lost in melting; calcn. of the cubical expansion; calcn. of batch from anal. or compn.

C. W. P.

Principles of glass making. R. R. SHIVELY. *The Ceramist*, **4**, 237–43(1924).—The chem. raw mats. used in the mfg. of glass together with their influence on phys. properties; method of making necessary batch calcns.; oxidizing agents; decoloring agents; color agents; opacifiers. C. W. P.

Principles of glass making. R. R. SHIVELY. *The Ceramist*, **4**, 287–93(1924).—Recent glass developments, causes and effect. Chiefly a summary of conclusions reported by W. E. S. TURNER and relating to the use of lower lime and higher alkali content in glass batches as a result of the introduction of automatic machinery. The resultant glass melts more rapidly, sets more slowly, anneals at lower temps., has lost some mech. strength and is less resistant to chem. corrosion. Granular soda ash has at least 5% greater efficiency than the powdered due to increased purity and decreased loss by moving gases of combustion. The manganese introduced as a decolorizer is nearly as valuable as alumina in influencing durability of glass. The substitution of selenium and consequent replacement of sodium nitrate by sodium carbonate has resulted in use of a greater alkali content. The use of salt cake has become more general. The amt. rarely exceeds one lb. per 100 of sand. It aids in preventing the formation of scum at the mtg. end of the tank and in getting rid of the organic matter. The use of ground burnt lime increases the mtg. capacity of tanks. C. W. P.

The principles of glass making, use of selenium in glass. R. R. SHIVELY. *The Ceramist*, **4**, 371–4(1924).—Use of selenium in this country was introduced by NICHOLAS KOPP in 1894. It has extended rapidly since the war. In the prepn. of ruby glass the usual constituents are sand, soda, zinc oxide, borax and bone ash. The amt. of selenium used varies from 5 to 18 lbs. and many glass makers use the same amt. of cadmium sulphide as selenium while others double that quantity. From 10 to 15% of zinc oxide is necessary. Selenium gives excellent results in the prepn. of amber glass. From 4 to 6 lbs. to 1000 lbs. of sand is used. A lime batch gives a wine color. True amber is produced in a lead batch. As a decolorizer 1 oz. of selenium is equivalent to not less than 10 lbs. of manganese. The amt. of selenium required to decolorize 100 lbs. of sand varies from $^1/_{10}$ to 1 oz. depending upon the iron content of the mats. used. Arsenic is used in almost every case and if the quantity is increased the amt. of selenium also must be increased. Use of niter necessitates an increased amt. of selenium. The same is true of salt cake. Because of the small amt. of selenium used, and its strength, it is recommended that it be diluted. A suitable ratio is 1 lb. to 7 lbs. of arsenic. C. W. P

A glass die. ANON. *Brit. Clayworker*, **33**, 237(1924). H. G. S.

The effect of various constituents on the viscosity of glass. S. ENGLISH. *Pottery Gaz. and Glass Trade Rev.*, **49**, 567, 1518(1924).—To the glass manufacturer, the viscosity of molten glass is perhaps its most important property. The glasses used consisted of a series of soda lime silicates, soda magnesia silicates, and soda alumina silicates obtained by a mol. substitution of one of these basic oxides for sodium oxide in a simple sodium silicate of the molecular formula, $2Na_2O_36SiO_2$. The "rotation" method was used for the viscosity detns. as it is applicable over a long range. The glass was melted from cullet in a standard-sized cylindrical unglazed porcelain beaker, and an iridio-platinum sheath fastened on the end of a porcelain rod was rotated on its own axis in the center of the beaker of glass. The time required for the iridio-platinum sheath to complete one revolution under different turning forces, at various temps., was detd., and the viscosity was obtained as a function of the product of the effective pull and the time of rotation. The app. was calibrated by using syrup, the viscosity of which was predetd. by ordinary methods. The viscosity curves from about 750 to 1400°C show how the viscosity is increased by substitution and decreased by a temp. rise. The logarithm curve indicated that the temp. interval required to halve the viscosity continued to increase as the temp. rose. P. D. H.

Alumina silica minerals in glasshouse pots and tank blocks. W. J. REES. *Pottery Gaz. and Glass Trade Rev.*, **49**, 567, 1518(1924).—This is a confirmation of the findings of N. L. BOWEN, and J. W. GREIG of the Geophysical Laboratory, Washington, D. C., with regard to there being only one compd. of alumina and silica stable at high temps., namely $3Al_2O_3.2SiO_2$, instead of its being sillimanite $Al_2O_3SiO_2$. The propn. of the former present in refrac. was found to depend on the compn. of the clay and the degree and duration of htg., and was influenced by contact with or absorption of silicate melts, such as glass. P. D. H.

The thermal endurance of glass. V. H. SCOTT. *Pottery Gaz. and Glass Trade Rev.*, **49**, 567, 1519(1924).—The ability of a glass to withstand thermal shocks depends upon the size and shape of the object and on the manner in which the shocks are applied. The expts. showed that rupture was generally produced by local differences in temp. rather than by the uniform contraction of large surfaces. As the fracture was almost instantaneous the condy. of the glass could be of little importance. P. D. H.

The origin of glass. ANON. *Pottery Gaz. and Glass Trade Rev.*, **49**, 567, 1519 (1924). P. D. H.

Colloidal protection. J. ALEXANDER. *Jour. Soc. Chem. Ind.*, **43**, 1256–8(1924).—Individual silicates in glass tend to crystallize, but in admixture they form a mutually protective chain, being so chosen by the glassmaker. If the mixt. is not right, or if it has been hot for too long, the chain breaks down and the glass devitrifies. The author defines a protector as a subs. that opposes the aggregation of molecules or particles into larger groups; and he deals with protection, plural protection, autoprotection, and cumulative protection. To establish some measure of protective action, ZSIGMONDY detd. the number of mgms. of protective subst. which would just fail to prevent 10 cc. of pure colloidal gold soln. 0.005–0.006% of gold from changing its color from red to violet upon addn. of 1 cc. 10% NaCl soln. A table of these "gold numbers" is given, all of organic subs. except stannic acid sol. H. H. S.

A study of recent attempts to produce high resistance glasses. W. E. S. TURNER. *Jour. Soc. Chem. Ind.*, **43**, 1262–3(1924).—Commencing with $Na_2O.3SiO_2$, the substitution of CaO for Na_2O increases stability. Glass contg. less than 2% CaO is rapidly attacked by water, and as the amt. of CaO increases beyond 3% the corrosion rapidly diminishes. Substitution of Na_2O by other alkaline earths or alumina gives similar results. Substitution of MgO for CaO gives a slightly more durable glass. Zirconia and titania give results intermediate between CaO and MgO. The mat. extracted from glass by corrosion varies with the type of glass, but the alkali constituents are always in excess in the soln. The order of soly. is: K_2O, Na_2O, B_2O_3, BaO, CaO, MgO, PbO, ZnO, Al_2O_3, SiO_2. Hence the more SiO_2 which can be melted into the glass the greater the durability. B_2O_3, although fairly sol., is exceptional in that it increases the durability if present up to 12%; it also reduces coeff. of expansion and enhances the optical properties of the glass. In 1893, high resist. borosilicate glass was made at Jena, and since then the use of B_2O_3 with high SiO_2 content has been extensively developed. Silica raises the fusion point, hence the limiting SiO_2 content is detd. by the ability to bring the mats. to fusion in operations on a commercial scale. H. H. S.

Census of glass manufacturing firms for 1923, compared with figures for 1921. ANON. (Dept. of Commerce.) *Nat. Glass Budget*, **40** [25], 3(1924).

Color imparted to glass by ceria. KITSUZO FUWA. *Jour. Jap. Cer. Assn.*, **32** [375], 91–3(1924).—Commercial ceria usually contains praseodymium and other rare earth metals. Its brown color varies with the content of the said element. F. has used a faint yellow ceria obtained by igniting the purest nitrate obtainable in the country. Chem. formulae of the glasses were $R'_2O.R''O.3SiO_2$ and $R'_2O.R''O.0.5B_2O_3.3SiO_2$, where R′ and R″ represent Na or K and Ca, Mg, Zn, Ba or Pb resp. I. *Influence of*

the compn. of glass upon its color given by ceria. Ceria gives a yellow to glass and the influence of its compn. on the color is slight. Strictly speaking, however, distinct influence is observable; *e. g.*, 2% ceria gave dark yellow to alkali-lead boro silicate glasses, while the same amt. imparted slight yellows to alkali-magnesium, zinc or barium silicate glasses. Generally speaking, the yellow is dark in lead glasses, clear dark in boron glasses and light in ordinary silicate glasses. Sodium-magnesium or zinc borosilicates have red shades, while potassium-calcium, barium or lead silicate glass tends to show a greenish tint. II. *Effect of oxidizing agent on the coloration.* 1% of potassium nitrate mixed to the batches has shown no effect on the coloration given by 2% of ceria. S. K.

Coloring glasses with copper (1st. report). KITSUZO FUWA. *Jour. Jap. Cer. Assn.*, **32** [376], 138–47(1924).—Coloring action of copper and its compds. on glasses with formula of $R'_2O.3SiO_2$, $R'_2O.R''O.3SiO_2$, $R'_2O.0.5B_2O_3.3SiO_2$, $R'_2O.R''O.0.5B_2O_3.3SiO_2$, $1.3R'_2O.R''0.6SiO_2$ or $R'_2O.B_2O_3.6SiO_2$ is reported. *Copper and its oxides.* (1) CuO. 1% of the oxide produced colors varying from slight blue to dark indigo. In general, soda glasses were colored darker than potash ones. Boron, barium or lead intensified the color. Boric acid encouraged the development of green. Effects of reheating glasses colored with 1–3% CuO are described. The potash borosilicate glass was covered with a thin ruby-red layer. (2) Cu_2O. Colors given by 1% of the oxide varied from slight to dark blues with exception of $K_2O.CaO.3SiO_2.K_2O.ZnO.0.5B_2O_3.3SiO_2$ and $1.3K_2O.ZnO.6SiO_2$ which were colorless, light purplish blue and light yellowish brown resp. (3) Cu. 1% of metallic copper imparted to most of the glasses colors varying from almost colorless to dark blue, while $R'_2O.CaO.3SiO_2.K_2O.ZnO.3SiO_2$ and $R'_2O.BaO.0.5B_2O_3.3SiO_2$ were colored yellowish brown, light yellow and greenish brown resp. Generally speaking, coloring action of metallic copper is still weaker than that of Cu_2O. *Copper salts.* (1) $CuCl_2.2H_2O$ and Cu_2Cl_2. 2.15% of cupric chloride gave the glasses blue or greenish blue of various intensities, except $K_2O.CaO.3SiO_2$ and $K_2O.ZnO.3SiO_2$ which were colored light and dark brown, resp. 1.25% of cuprous chloride colored $Na_2O.BaO.3SiO_2.Na_2O.ZnO.0.5B_2O_3.3SiO_2$ and $K_2O.CaO.0.5B_2O_3.3SiO_2$ dark brown, light yellow and brown, resp., the other glasses being colored blue. (2) $CuSO_4.5H_2O$. 3.15% of the sulphate imparted blues or indigo blues to most of the glasses, though $Na_2O.ZnO.3SiO_2$ was brown and $K_2O.BaO.3SiO_2$ dark blackish brown. All batches contg. lead produced a dark blue alabaster, probably owing to the formation of lead sulphate. (3) $Cu(NO_3)_2.6$ aq. 3.75% of the nitrate produced blue, dark blue or indigo blue in all glasses. The blue coloration is even stronger than that with CuO. (4) $CuCO_3.Cu(OH)_2$. 1.4% of malachite green produced opaque vermilion in $Na_2O.CaO.3SiO_2$ and opaque dark brown in $K_2O.CaO.3SiO_2$, while it gave various blues to other glasses. (5) $Cu(C_2H_3O_2)_2$.aq. 2.52% of the acetate gave light yellow, yellowish green, yellowish, reddish or greenish brown to the glasses with exception of $Na_2O.CaO.3SiO_2$ and $Na_2O.PbO.3SiO_2$ which were colored blue. S. K.

Coloring glasses with copper (2nd rept.). KITSUZO FUWA. *Jour. Jap. Cer. Assoc.*, **32** [377], 167–78(1924).—*Effect of oxidizing agent on colors produced by copper and its oxides.* Full coloring power of 1% CuO was developed in batches contg. same amt. of niter, while 1–2% of niter were required to produce deepest blue with 1% of Cu_2O or metallic copper. *Effect of oxidizing agent on colors produced by copper salts.* 1–4% of the oxidizing agent was added to those batches which had produced colorless glasses or glasses with colors other than blue in the expts. described in the first report. Batches with cupric chloride required 1–2% of the oxidizing agent to produce a blue. Those with cuprous chloride, copper sulphate or basic carbonate gave blue glasses with 1% of niter. Batches with copper acetate required 1–4% for the same purpose. Generally speaking, potash glasses seem to consume more niter than soda glasses. *Effect*

of reducing agent on colors produced by copper oxides. (1) Cupric oxide. In an expt. with batches contg. 1% of cupric oxide after melting, 0.5% of potassium tartrate produced a red in $Na_2O.CaO.3SiO_2$ or $K_2O.ZnO.3SiO_2$, a light pink in $Na_2O.BaO.3SiO_2$ and a reddish brown in $1.3Na_2O.CaO.6SiO_2$, while its 0.5–5.0% produced blues or browns in the other glasses. Nodules of copper or lead were found very often on the bottom of pots. (2) Cuprous oxide. Addition of 0.5% of the reducing agent together with 1.0% of cuprous oxide resulted in the production of a brown glass in most cases, though a few glasses were colored light blue. *Effect of reducing agent on colors produced by copper salts.* The proportion of a copper salt in a batch was such that its oxide corresponded to 1% of the glass. (1) Cupric chloride. Only 0.5% of the reducing agent revealed marked changes in color of $R'_2O.R''O.3SiO_2$; *e. g.*, $K_2O.CaO.3SiO_2$ and $Na_2O.BaO.3SiO_2$ gave a dark red glass. The effect was much more gradual in borosilicate glasses. (2) Cuprous chloride. Compns. of the glasses have shown strong influence on the action of the reducing agent, and the influence of R″O seems to be stronger than that of R'_2O. (3) Copper sulphate. $R'_2O.R''O.3SiO_2$ glasses were colored brown by 1–2% of the reducing agent, while borosilicate glasses required its 5% for it. (4) Copper nitrate. The salt consumed much more reducing agent than other salts in melting. (5) Basic carbonate of copper. Brown opaque glasses were obtained with 1–5% of the reducing agent. S. K.

Coloring glasses with copper (3rd rept.). Kitsuzo Fuwa. *Jour. Jap. Cer. Assn.*, **32** [378], 204–33(1924).—*Effect of arsenious acid on colors produced by copper and its oxides.* (1) Cupric oxide. Arsenious acid produced reds in soda-lime glasses. In many other glasses, it reduced the oxide to metallic copper and caused only a slight change in colors. (2) Cuprous oxide. Red glasses were given with $Na_2O.CaO.3SiO_2$ and zinc glasses, while the other glasses showed only slight changes in colors, the oxide being generally reduced to metallic globules. (3) Metallic copper. The results obtained with metallic copper and its oxides indicate that arsenious acid acts to reduce the oxides and also to accelerate the growth of copper particles. *Effect of arsenious acid on colors produced by copper salts.* The action is chiefly a reduction, copper globules or red glasses being produced. However, no or slight effect was observed in batches contg. nitrate or acetate of copper. *Effect of stannic oxide on colors produced by copper and its oxides.* The effect of stannic oxide on the colors is not alike in different glasses. However, it seems to act as a reducing agent. Of 42 batches contg. 1% of cupric oxide and 0.5–2.0% of stannic oxide, only 6 batches of $Na_2O.CaO$ (or ZnO).$3SiO_2$ and $1.3K_2O.ZnO.6SiO_2$ gave red glasses. *Effect of stannic oxide on colors produced by copper salts.* The influence of variation in compn. of the glasses, kind of salts and their amt. on the action of stannic oxide is very strong. The oxide seems sometimes to act even as an oxidizing agent. *Effect of antimony oxide on colors produced by copper oxides.* The effect of antimony oxide resembles that of stannic oxide when cupric oxide is concerned. It is very slight for cuprous oxide. *Comparison of the effect of stannic oxide and antimony oxide on colors produced by copper oxides.* Antimony oxide seems to have stronger effect in changing colors produced by cupric oxide than stannic oxide. It is quite reverse for cuprous oxide. Antimony oxide tends to produce metallic copper, while stannic oxide tends to develop ruby colors. *Effect of reducing agent and stannic oxide on colors produced by cuprous oxide.* Generally speaking, an addition of potassium tartrate together with stannic oxide produces a darker color than that obtained when one of them is used. *Effect of stannic oxide and arsenious acid on colors produced by cupric oxide.* The result of tedious expts. is very complicated. *Effect of antimony oxide and potassium tartrate on colors produced by cuprous oxide.* Glasses have shown suspensoid of metallic copper or sufficient deposit of copper globules, indicating reducing action of antimony oxide and the tartrate. *Effect of antimony oxide and arsenious acid on colors produced by cuprous oxide.* The result of numerous meltings indicates that their effect is very slight. S. K.

On the weathering of bulb glass. SANGORO TAKAHASHI. *Jour. Jap. Cer. Assn.*, **32** [378], 233–8(1924).—Resistance of two bulb glasses, $0.9Na_2O.1.1PbO.6SiO_2$ and $1.3Na_2O.0.7CaO.6SiO_2$, to weathering has been studied. I. Expts. on storing. The following tables show the results.

TABLE I. WEATHERING IN A CONCRETE STOCK-HOUSE

Methods of storing	After 1 month		After 2 months		After 3 months		Ease of washing weathered products off	
	The lead glass	The lime glass	The lead glass	The lime glass	The lead glass	The lime glass	The lead glass	The lime glass
Packed as usual	Dimmed	Dendritic crystals	Spotted	Dendritic crystals	Snow-like crystals	Dendritic crystals	Very difficult	Pretty difficult
Packed as usual, but together with Adsol (fullers' earth)	None	None	Dimmed	Dendritic crystals	Spotted	Dendritic crystals	Difficult	Easy
Packed as usual, after washing with dil. HCl	None	None	None	Granular crystals	Almost none	Granular crystals	Easy	Easy

TABLE II. WEATHERING OF BULBS, WASHED WITH VARIOUS REAGENTS, IN AN APPARATUS SATURATED WITH WATER-VAPOR AND 40°C HOT

Solutions	After a week		After two weeks		Ease of washing weathered products off	
	The lead glass	The lime glass	The lead glass	The lime glass	The lead glass	The lime glass
1/50 *N* H_2SO_4	None	Dendritic crystals	Fairly dimmed	Dendritic crystals	Fairly difficult	Fairly difficult
1/500 *N* HCl	None	Fairly dimmed	None	Dimmed	Good	Easy
Water (10°C)	None	Fairly dimmed	Fairly dimmed	Dimmed	Fairly difficult	Easy
Water (70°C)	None	Fairly dimmed	None	Dimmed	Good	Easy
Unwashed bulb	Spotted	Dendritic crystals	Snow-like crystals	Dendritic crystals	Very difficult	Fairly difficult

II. Expts. on glass compn. The effect of introducing some ingredients to above glasses has been studied with results as follows:

TABLE III. WEATHERING OF BULB GLASSES CONTAINING SPECIAL INGREDIENTS

Ingredients	After a week		After two weeks		Ease of washing weathered products off	
	The lead glass	The lime glass	The lead glass	The lime glass	The lead glass	The lime glass
None	Spotted	Dendritic crystals	Snow-like crystals	Dendritic crystals	Very difficult	Fairly difficult
B_2O_3 3.0%	Fairly dimmed	Cluster of crystals	Dimmed	Cluster of crystals	Difficult	Easy

TABLE III (*Continued*)

Ingredients	After a week		After two weeks		Ease of washing weathered products off	
	The lead glass	The lime glass	The lead glass	The lime glass	The lead glass	The lime glass
Al_2O_3 3.0%	None	Fairly dimmed	Fairly dimmed	Minute crystals	Fairly difficult	Easy
TiO_2 1.5%	Fairly dimmed	Dimmed	Fairly dimmed	Dimmed	Fairly difficult	Easy
ZrO_2 1.5%	None	Fairly dimmed	Fairly dimmed	Minute crystals	Fairly difficult	Easy
SnO_2 1.5%	None	Fairly dimmed	Fairly dimmed	Granular crystals	Fairly difficult	Easy
ThO_2 1.5%	None	Fairly dimmed	Fairly dimmed	Minute crystals	Fairly difficult	Easy

The effect of replacing a part of soda by potash has been experimented.

TABLE IV. WEATHERING OF BULB GLASSES WHOSE SODA HAS BEEN PARTIALLY REPLACED BY POTASH

Per cent potash in total alkalis	After a week		After two weeks		Ease of washing weathered products off	
	The lead glass	The lime glass	The lead glass	The lime glass	The lead glass	The lime glass
40%	None	Fairly dimmed	None	Cluster of crystals	Easy	Easy
50%	None	Almost none	None	Cluster of crystals	Easy	Easy
70%	None	Almost none	Minute crystals	Minute crystals	Easy	Easy
100%	Fairly dimmed	Spotted	Granular crystals	Thin film	Fairly difficult	Fairly difficult

S. K.

The electrolysis of soda-lime glass. I. Evolution of gas and its relation to sorption and conductivity. J. W. REBBECK AND J. B. FERGUSON. *J. Am. Chem. Soc.*, **46,** 1991–2002(1924).—The reversible phenomena of gas evolution which take place during the electrolysis of glass under proper conditions have been shown to be due probably to the action of Na upon the sorbed water and the simultaneous electrolysis of the hydroxide formed. Appreciable gas evolution may be obtained with voltages as low as 1.3 v. The sorption of water does not affect the resistance of soda-lime glass. The evolution of gas on electrolysis constitutes a new method for studying the *sorption of water by glass*. The possible adsorption of H ions by glass and also their elec. migration into glass are indicated. F. L. B. (*C. A.*)

The production of high-grade colorless glass in tank furnaces. G. O. SMITH. *Glass Ind.*, **5,** 1–2(1924).—Se as a decolorizer is recommended and hints are given for its use. J. B. P. (*C. A.*)

Modern blown bottles. C. W. AKERLOW. *Glass Ind.*, **4,** 185–8(1923).—Defects and remedies in the blowing of bottles by the Owens machine are noted. J. B. P. (*C. A.*)

The etching and polishing of glass. O. SCHARTZBACH. *Diamant*, **45,** 369(1923).—The carefully cleaned glass is subjected to a preliminary treatment in a dil. soln. of HF. If a fine-grained mat surface is desired, a soln. of acid KF in H_2O to which 10–20% of

NH_4F has been added is recommended as a bath. The Na salt gives a coarser mat. A dip in a dil. HF bath tends to dissolve off the mat surface. Strong acid dissolves the glass unevenly, yielding a poor surface. A 50% soln. of com. HF in H_2O is suggested for etching potash glasses. Na_2SiF_6 being more sol. than the K salt, a stronger acid is required for Na glasses to get the same results. The addition of concd. H_2SO_4 to strong HF causes the evolution of bubbles of gaseous HF, which produces line etching on coming in contact with glass. By gentle agitation the lines upon the glass may be formed as spirals. A bath of H_2SO_4 2 and HF 1 is favorable to line etching. Combinations of these etching methods with the etching of designs on glass through wax produce beautiful effects. In mat etching as outlined above the evolution of gas bubbles is avoided as far as possible. By adding 6 parts of H_2SO_4 to 1 of HF the bath becomes so viscous that the liberation of the bubbles is hindered and small globules attach themselves to the glass surface, insulating it temporarily from further attack at that point. Thus in this way also a mat surface is etched upon the glass the bubbles acting similarly to the protective salts on the glass surface. J. B. P. (*C. A.*)

The silvering of glass ornaments. Otto Wilhelmy. *Diamant*, **45**, 337–8(1923).—Detailed instructions. J. B. P. (*C. A.*)

Problems of the German glass industry. Hugo Kühl. *Diamant*, **46**, 217–8 (1924).—A discussion mainly of German raw materials. J. B. P. (*C. A.*)

The Fourcault process of drawing sheet glass at Clarksburg. Anon. *Glass Ind.*, **5**, 59–68(1924); 18 figs.—A description of the process and the new plant of the Am. Sheet Glass Co. J. B. P. (*C. A.*)

The design of a 14-pot recuperative glass furnace. E. W. Koering. *Glass Ind.*, **5**, 105–9(1924); illus.—Includes a small bibliography. J. B. P. (*C. A.*)

Operating glass tanks. B. Schieldrop. *Fuels & Furnaces*, **2**, 43–6(1924); cf. *ibid*, **1**, 443; and *C. A.*, **18**, 315.—Data and method for calcg. the amt. of heat required to melt the batch and cullet assuming the elimination of all losses are given. D. F. B. (*C. A.*)

Jena glass. Thiene. *Keram. Rundschau*, **32**, 66–8; *Glass Ind.*, **5**, 81–2(1924).—An account of the different divisions of glass manuf. of Schott & Co. D. E. S. (*C. A.*)

Certain effects produced by chilling glass. A. Q. Tool and C. G. Eichlin. *J. Optical Soc. Am.*, **8**, 419–50(1924).—The view is advocated that at every temp. glass tends toward an equil. condition which is a function of that temp. While the condition of perfect stability at room temp. may never be reached, because the mobility of glass becomes too low, it is shown from the results of expts. that what appear to be stable conditions for given temps. are approached with rapidity at temps. slightly above the usual annealing range. In procuring the data on which this conclusion is based heating curves were obtained on samples of glass, each of which had received one of a number of different annealing and chilling treatments. A method of comparing these curves was devised to show more clearly the effect of these treatments on the characteristic heat absorption and evolution effects in glass. It was also found that the density of the glass in agreement with the above view differed markedly with the treatment the glass had received, and that the treatment required to produce either an increase or decrease in the vol. could be detd. from a study of the heating curves. The effects observed are discussed in detail, the conclusion being that they result either from the continual formation of more complex mols. or aggregates or from the general tendency of the mols. to assume a greater compactness as the temp. is lowered, and from their disintegration or sepn. on heating. Such transformations coupled with the tendency of these substances to become superheated or undercooled because of the low mobility of the glass are shown to be sufficient to explain all heat effects observed in the annealing region. Mention is made of the bearing of the results of this investigation on problems

in practical glass manuf. involving the durability, stability, deformability, coloration, crystn., homogeneity, and such heat treatments as annealing and hardening. The possible relation between the vol. changes observed and the ice point fluctuations in thermometers and the breakage of unequally heated glasses, such as searchlight mirrors, is also pointed out. G. E. B. (*C. A.*)

Fused, bubble-free quartz; an historical rectification. M. v. SCHWARZ. *Physik. Z.* **25,** 374–6(1924).—Attention is called to the fact that in 1913 Hugo Helberger produced fused quartz, free from bubbles and strain, in pieces as large as one's fist, and suitable for use in optical instruments. The quartz was fused *in vacuo* and cooled under the pressure of a compressed gas. HELBERGER's patent specifications are described, and photographs are given of the furnace and of specimens of the quartz. This article was occasioned by the description of an apparently similar process published recently by the General Electric Co. R. H. L. (*C. A.*)

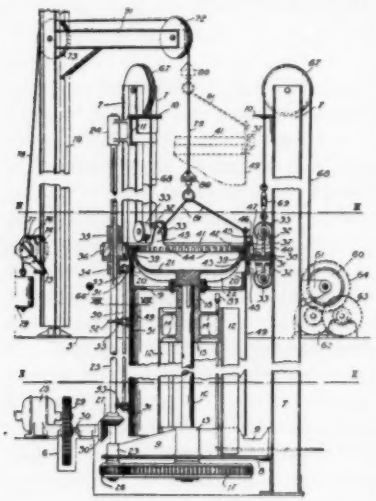
Viscosity of glass. H. LE CHATELIER. (Meeting Acad. des Sciences, Oct. 20, 1924.) *J. Soc. Chem. Ind.*, **43,** 1255(1924).—Within a temp. difference of 500 to 1000°C the viscosity of glass may vary from 1 to 1 milliard. H. H. S.

Special sands. W. M. WEIGEL. *Repts. of Investigation*, No. **2646**(1924).—Dept. of Interior, Bur. Mines Serial. P. D. H.

PATENTS

Mold for making glass spark-plug bushings. MAURICE A. SMITH and JOSEPH BLAZE. U. S. 1,522,150, Jan. 6, 1925. A glass-molding app. comprising a mold having a plurality of molding cavities, separately mounted plungers adapted to reciprocate vertically into and out of said cavities, and means for simultaneously reciprocating all of said plungers.

Process of making high-grade glass. CHARLES E. PARSONS. U. S. 1,522,697, Jan. 13, 1925. The process of making glass from blast fur. slag which consists in finely dividing said slag; digesting the finely divided slag with a soln. of an alkali metal silicate to form calcium and magnesium silicates; sepg. out said calcium and magnesium silicates; adding to the latter such other constituents as are necessary to complete a desired glass making charge; and causing the constituents of the completed charge to react to form the desired glass.

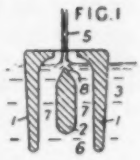


Method of and apparatus for making glass. WALTER O. AMSLER. U. S. 1,523,157, Jan. 6, 1925. App. for the manuf. of glass cylinders comprising a supporting frame, a receptacle supported in the frame, means for rotating the receptacle, a drive-ring movable longitudinally in the frame, means for effecting the longitudinal movement of the drive-ring, means for rotating the drive-ring at substantially the same speed as the receptacle, a mold cylinder carried by the drive-ring, a draw-ring carried by the drive-ring and movable therewith, and means for effecting a sep. movement of the draw-ring.

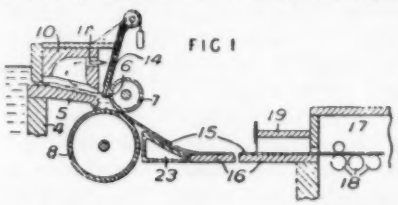
Glass. F. M. OPPERMANN. Brit. 216,494, May 23, 1923. Ingredients of a batch for glass making are melted in a pot or tank furnace and the "metal" is ladled or poured into a pot which is placed in a refining furnace. After the "metal" is completely refined, the pot is removed and placed in a tunnel through which it is mechanically conveyed. The

tunnel is heated (similarly to the usual form of leer) so that when the pot reaches the exit the "metal" has cooled to the working temp. (*C. A.*)

Glass manufacture. PILKINGTON BROS., LTD., GLASS WORKS, and D. RAILTON. Eng. Pat. 13,622(1923); *Pottery Gaz. and Glass Trade Rev.*, **49** [567], 1536(1924). In an app. for drawing sheet glass the metal is conducted from a region below the surface of the molten mass through two channels to the two sides respectively of the line of draw, in order to secure an even temp. on both sides of the sheet at the drawing point. App. for carrying out the process consists of a refrac. structure, comprising outer walls 1 and a central partition 2, which is inserted in the mass 3 of the molten glass, as shown. The sheet 5 is drawn from a line above a ridge 8 formed on the partition 2, and the metal that forms the sheet is drawn from a region 6 below the surface of the molten mass and flows to the drawing point through the two channels 7 at the sides of the partition. The outer walls 1 may be continued upwards to form a drawing-chamber, and they may be integral with or separate from the partition 2. In the latter case the partition and the walls may be movable relatively to one another so that, by varying the width of the channels 7, any difference of temp. between the two streams of metal may be compensated.



Glass manufacture. PILKINGTON BROS., LTD., GLASS WORKS, and E. B. LE MARE. Eng. Pat. 6,094(1923); *Pottery Gaz. and Glass Trade Rev.*, **49** [567], 1536 (1924). In a process of producing a continuous strip of glass by rolling molten glass as it issues from a tank fur., the strip as it issues from between the rollers is drawn over a flat stationary bed on its way to the leer, the bed being of such a length that the plastic strip becomes flattened and sets before it passes on to the rollers in the leer. The glass issues from the tank 4 by a shoot 5 and forms a pool 6 in the pass between the rollers 7, 8. The shoot is provided with side walls and a crown 10, and the space thus formed is htd. by burners 11. An adjustable gate 14 regulates the arc of contact between the pool and the roller 7, and this arc is less than that between the pool and the roller 8. The glass strip 15 as it issues from between the rollers passes on to a stationary bed 16, 23 and thence into the leer 17, where it is supported on rollers 18 which are also rotated to draw the strips. The bed consists of a curved portion 23 and a flat portion 16, part of which may be covered by a hood 19 to enable the rate of cooling of the strip of glass to be controlled. The flat bed enables the sheet to become flattened by its own weight, and the length of the bed is such that the strip has become sufficiently hardened by the time it enters the leer to resist deformation when passing over the rollers 18. The shoot 5 may be replaced by a short horizontal conduit or even a slot in the wall of the tank. The rollers are preferably arranged, as shown, with the upper one in advance of the lower, but they may be vertically one above the other or their axes may be in the same horizontal plane. The lower roller is preferably of greater diameter than the upper roller, and may be replaced by a chain table of any known construction.



Heavy Clay Products

How a notebook helped to build a real plant. ANON. *Brick and Clay Rec.*, **65** [12], 827–31(1924).—The new plant of the Darlington Clay Products Co. at Darlington, Pa., is described fully. The plant was designed by C. FORREST TEFFT. A layout is given showing the location of equipment and the size of motor drives. A number of photographs are also shown. Gray and manganese face brick are manufd. The plant is

operating on a No. 2 fire clay known as Lower Kittanning which is taken from a drift mine 1/4 mile away. The clay is crushed at the mouth of the mine, dumped into 1 1/2 yd. "V" type dump cars and hauled to the plant by a Plymouth gasoline locomotive. The clay is dumped onto a link-belt plate feeder which feeds the clay onto a 20-inch rubber conveyor belt 90 ft. in length and operating at an angle of 22 1/2° to the horizontal. From this the clay is dumped onto an 85 ft. horizontal conveyor belt, which runs the length of the 1500 ton storage bin in the monitor of the building. Old belts are used as scrapers to push the clay off the conveyor belt. The two conveyor belts and the plate feeder are driven by a 10-h. p. motor. There are 4 reclaiming conveyors, two at each side of and running at right angles to an aisle in the center of the building. These 4 different workings insure uniformity of clay. The conveyor tunnels are sufficiently large to admit a workman readily. The 4 conveyors feed onto a 40 ft. inclined conveyor, at right angles to them, which delivers the clay to the dry pan and also serves as a power transmission belt, operated from the dry pan. The tail shaft of the inclined belt is extended beyond the bearings just far enough to take miter gears which mesh with other gears on short jack shafts. These short shafts which are parallel to the shafts carrying the head pulleys of the reclaiming conveyors are connected with them by sprockets and chains. Four clutches enable any one of the conveyors to be operated at will. The dry pan is a 9-ft. Chambers overhung type with cone shaped bottom. It is belt driven by a 75-h. p. motor. From the dry pan the clay is carried in a bucket elevator to a height of 21 ft. where it is dumped onto a 16-mesh Hummer screen. Over 12 T. of clay are ground and screened per hour. The clay is again elevated the same height and dumped into a steel bin of about 60 T. capacity, the concrete bottom of which is being lined with maple wood in order to insure a free flow of clay. A double elevator and low height screen are used in order to cut down the power required to lift the tailings to the screen, 60% of this material being tailings. A 15-h. p. motor drives both elevators and screen distributor. The clay is fed from the bottom of the bin by a disc feeder into the hopper of a poidometer which delivers it to a screw conveyor. Ground manganese is fed into the same screw conveyor by a parallel poidometer. An elevator then delivers the clay to a Chambers pug mill, from which it is carried on a flight conveyor to the auger machine. A 75-h. p. motor drives the brick machine; a 40-h. p. motor drives the pug mill; and a 20-h. p. motor drives the line shaft, the cutter, conveyor, belts, screw conveyor, poidometers and disc feeder. A complete switch board including a recording voltmeter has been installed. Burke motors and "Condor" brand belts are used throughout. The plant has a daily capacity of 36,000 bricks. The drying and firing system was fully described in *Brick and Clay Rec.*, April 17, May 1, and May 15, 1923. The driers are heated by radiated heat from the products of combustion which are drawn through cast iron pipes beneath the cars. The brick are fired in round down-draft kilns with natural gas. From 25 to 30 men are required to operate the plant.

P. D. H.

Making brick and tile in Durban, South Africa. ANON. *The Clay Worker*, **82** [3], 200–1(1924).—The plant of the Coronation Brick and Tile works is described. It has an annual production of 29 million brick. P. D. H.

Plant and output of the Birmingham Clay Products Co. ANON. *The Clay Worker*, **82** [3], 202(1924).—The plant is located at Sibleyville, Ala. Common brick, red rough textures, buff and flash brick in smooth and rough textures are made. The daily capacity of the plant is 50,000 face bricks and 25,000 common bricks. The ware is fired in a Haigh continuous kiln and in round and rectangular down-draft kilns. P. D. H.

Firing brick with industrial gas. HUGH H. WIKLE. *The Clay Worker*, **82** [3], 217–20(1924).—City gas was first used in the firing of brick in November, 1923, at the plant of the Lake View Brick Co., of Chicago, Ill. No permanent kilns are used. The

brick are piled in huge rectangular piles, 34 ft. wide, 40 ft. long and 12 ft. high. Arches, 2 ft. high and 18 in. wide, are left every 4 ft. They extend the entire width of the kiln. The brick are set 3 on 3. The gas is delivered to the burners at 12 lbs. pressure. About 20 hrs. are required to fire off a kiln. The gas consumption is about 78,000 cu. ft. per 39,000 bricks. The cost of firing with gas is $1.80 per thousand brick, whereas the cost of coal and wood which was formerly used was $2.00 per thousand. Gas has the following advantages over coal and wood fuel: (1) Decrease of over 50% in the firing time; (2) decrease of 66% in labor; (3) more contented workmen; (4) better brick; (5) less loss due to overfired and underfired brick; (6) no storage space required for gas; (7) no smoke nuisance. P. D. H.

With the Kanes at Kushequa. ANON. *The Clay Worker*, **82** [4], 300–03(1924).—The plants of the Kushequa Keramic Co. and Kushequa Brick Co., at Kushequa, Pa., are described. The former plant manuf. unglazed floor tile by forcing the plastic clay through a die and cutting the tile from the clay column by a special type cutter. After being dried in direct-fired driers for a week, the ware is set in 28-ft. round down-draft gas fired kilns 7 benches high with a row of fire clay slabs between the 4th, 5th, 6th and 7th benches to keep the rings vertical and to prevent warping. Each bench is 5 tiles in thickness. The ware is fired to 1875°F. The brick plant manuf. smooth and rough face brick, paving and floor brick. P. D. H.

Making brick at West Point. ANON. *The Clay Worker*, **82** [5], 384–5(1924).—The plant of the West Point Brick and Lumber Co., of West Point, Ky., is described. The plant has a daily capacity of 30,000 bricks of which 60% are rough texture face brick and 40% are red common brick. The raw material is a surface clay which is being worked to a depth of about 12 ft. by a steam shovel, there being no stripping. From the dump trucks, the clay is delivered to a Potts crusher on a feeder belt, thence into a Freeze pug mill and on into a Freeze stiff mud machine. The brick are dried in a waste heat tunnel drier and fired in 6 down-draft coal fired 32 ft. kilns, each having a capacity of 90,000 bricks. The firing is done in from 7 to 8 days. There is a water smoking period of about 24 hrs. during which a temp. of 1200°F is reached. A temp. of 1750° is reached in the next 24 hrs. The temp. is then held at from 1750° to 1800° for 5 days, in order to complete the firing and settling, there being 16 in. of settle to a kiln set 32 courses high. One ton of coal per 1000 bricks is used in firing. P. D. H.

Modern tile making. XX. ALFRED B. SEARLE. *Brit. Clayworker*, **33**, 222–4 (1924). H. G. S.

A call for extended brick-making operations. ANON. *Brit. Clayworker*, **33**, 227–8(1924).—The hand molding and wire cut methods of mfg. brick are described. H. G. S.

Breakdowns in brickworks. ANON. *Brit. Clayworker*, **33**, 236(1924). H. G. S.

A new brick machine. ANON. *Brit. Clayworker*, **33**, 237–8(1924).—A fault which is common to ordinary brick machines lies in the fact that the cog wheels, bearings, and shaft are exposed and unprotected so that dust and dirt have access to these parts, causing unnecessary wear and tear and power consumption. The makers have in previous years attempted to overcome this trouble by boxing in the wheels and running them in oil baths, and the whole driving mechanism was enclosed in sheet metal casings, but all of these methods proved unsatisfactory. A new machine, designed by MAX LIEBSCHER, Meissen, Germany, was exhibited in opern. at Leipzig. The external appearance of this mach. represents a complete change, no moving parts, with the exception of the belt pulley, being visible. All wheels, bearings, shafts, etc., are enclosed in a cast iron cylinder with a removable lid, the casing being completely dustproof and oil tight. The wheels and shafts are made of steel. The wheels have planed teeth and run in oil baths, so that the machine runs smoothly and almost noiselessly. The shafts

run on strong, specially constructed roller bearings. The worm and its casing are made of special steel and their design is based on many years experience. The feed roller is also cased in and is closed by means of an adjustable scraper, so that there is no extrusion of clay. The outside of the machine is therefore always tidy and clean. The machine has a high gearing ratio and can therefore be driven direct from an electric motor, but any form of transmission is equally suitable. This gearing arrangement permits the use of ordinary light belts, thus eliminating the troublesome repair of belts. Furthermore, the belt is not subjected to the usual wear and tear of throwing in and out, since the driving pulley is constructed to act as a friction clutch, which can be regulated to "give" against excessive resist. H. G. S.

The effect of grading of sand upon the properties of sand-lime brick. H. V. JOHNSON. *Rock Products*, **27** [6], 31–3(1924).—Tensile (*a*), transverse (*b*), and compressive (*c*) strengths all increase with increases in the % sand finer than 100 mesh even beyond the point of max. d. The av. ratios for the exptl. mixts. were $a : b : c = 1 : 2.5 : 14$. The ratio $b : c = 2.5 : 14$ (or $1 : 5.6$) compares favorably to the ratio $1 : 4.6$ which was an av. for 10 com. bricks. The chief disadvantage of adding fine material beyond the point of max. d. is the resulting increase in absorption.

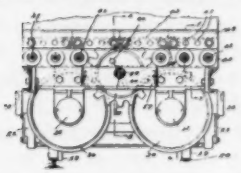
C. H. K. (*C. A.*)

The modern sand-lime brick plant. C. A. BRESKIN. *Rock Products*, **26**, No. 26, 81–4(1923).—A description of the plant of the Grande Brick Co., Grand Rapids, Mich.

E. H. (*C. A.*)

PATENTS

Vitrified product and process of making same. ARILLE DE GALLAIX. U. S. 1,523,179, Jan. 6, 1925. The herein described vitrified ceramic products composed essentially of powdered slag, powdered grog and plastic clay, the same being fired at a temperature high enough to vitrify the same throughout, such products being substantially impervious to water, oil and grease, and unaffected by frost and atmospheric conditions and being stable against shock.



Transfer car. RAYMOND C. PENFIELD. U. S. 1,523,606, Jan. 20, 1925. An improved transfer car for brick and the like, comprising a frame, a plurality of transversely arranged open troughs mounted thereon, a plurality of rollers mounted in each of said troughs, a platform element comprising a plurality of articulated members arranged in said troughs and movable over said rollers, and means mounted in said frame for moving all of said groups or articulated members simultaneously and transversely of the frame.

Refractories

Refractory minerals produced at Kanakura mine. ANON. *Jour. Jap. Cer. Assn.*, **32** [378], 251(1924).—A white mineral, called "Tōa-hakuseki," is produced with diaspore at Kanakura mine in Shimotakai-gun, Nagano Prefecture. Both minerals are considered as decompn. products of porphyrite. An anal. of the "Tōa-hakuseki," reported by the Imperial Geol. Surv., is: Water 24.28, silica 39.38, ferric oxide 0, alumina 36.94, lime 0, magnesia trace and alkalis 0. It is very probable that the mineral is Newtonite ($Al_2O_3.2SiO_2.4H_2O$ + aq.) contaminated with small proportion of diaspore ($Al_2O_3.H_2O$). Greenish "Roseki" (meaning "wax-clay"), found under the diaspore, has compn. as follows:

	Ig. loss	Silica	Alumina	Ferric oxide	Titanic anhydride	Lime	Magnesium	Total
(1)	6.83	58.66	32.25	trace	1.88	0.65	trace	100.27
(2)	8.38	58.77	29.40	trace	4.18	2.15	trace	99.88

S. K.

The heat effect on refractory clays and their mixtures. SHINZO SATOH. *Sci. Repts.*, Tohoku Imp. Univ., Series III, **1** [3], 157–201(1923).—I. *Thermal expansion and contraction.* (1) Firing contraction of raw refrac. clay. Dried specimens, formed by molding plastic masses of 3 typical clays, whose compns. were used, are as follows:

		SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	KNaO	Ig. loss	Air shrinkage	Refractoriness
A	Mitsuishi Roseki	43.30	48.16	0.26	0.26	0.01	1.52	8.02	1.4	SK 34
B	Owari plastic shale	48.02	34.02	1.93	0.54	0.17	0.54	15.35	8.2	SK 33
C	Mino plastic kaolin	52.20	33.84	1.81	0.43	0.03	0.70	11.63	6.4	SK 31

Clay A expanded gradually with the rise of temp. up to 700°C; after remaining constant to 900°, the expansion began to decrease and became zero at 1180°. Then, the contraction increased rapidly. The curve of clay B shows a slight contraction at the beginning of the heating and a slight expansion in 300–580°C. Such an initial contraction is not shown in the curve of clay C, indicating only a slight expansion in 300–550°C. Thus, the firing contraction of raw refrac. clay may be classified into two types, one of which expands at low temps., while the other contracts without a marked expansion. (2) Firing contraction of clay mixt. The specimens were cut from green glass pots which had been made of the three clays and broken pots. The result indicates that firing contraction of a clay mixt. is a resultant of contractions of the constituent clays. The shape of the firing contraction curve and the amt. of the final contraction vary with the ratio of the constituent clays. It was also found that (*a*) the pot body, previously heated, follows the ordinary law of thermal expansion and contraction, until the temp. approaches that previously reached and then the change takes its characteristic course, also that (*b*) the htg. curve of pot body takes a cuspidal form at a temp. between 500° and 700°C and after being once fired at a very high temp., the complicated length change, which will happen below the temp., vanishes. (3) Firing contraction at a constant temp. The results obtained with clays and pot bodies which were heated at several constant temps. ranging from 900° to 1270°C are very well expressed by the empirical formula $x/(C-x) = A/(C-A)-Kt$. Where x is the amt. of contraction at time t, A the initial length of the specimen, C the final contraction after heating infinitely long at a constant temp., and K a constant. II–IV. *Endothermal and exothermal reaction.* Determination of the dehydration point of clay with a thermo-balance; the change of the microstructure of clay by heating. Conclusions of these expts. are: (*a*) The dehydration of the constitutional water of kaolinite takes place between 400° and 600°C; (*b*) the dissociation of kaolinite into aluminium silicate and free silica commences very probably at 650°C; (*c*) the internal change takes place between 900° and 1000°C and it is probably a polymerization of the dissociated aluminium silicate; (*d*) between 1200° and 1300°C, we have also another internal change, which may be taken as the result of recombination of free silica and aluminium silicate formerly dissociated at lower temp. V. *Microstructure of stone.* Experimenting with bulb glass, stones have been classified into 4 kinds: (*a*) Unfused quartz grains coming from pot mats; (*b*) ditto coming from glass batch; (*c*) clay subs. coming from pot material; and (*d*) insol. foreign mineral coming from pot mat. as well as glass batch. 78 microphotographs are given. S. K.

Constitution and microstructure of silica brick and chamotte block used in tank furnace. ZENZIRO UNENO. Research Lab., Asahi Glass Co., *Rept.* **10**, 67(1923).—I. *Silica brick.* Descriptions on the microstructure of typical Amer. ganister-quartzites as well as silica brick made in Amer. and Belgium are given. (1) Quartzites of

Manchuria and Korea. Chief kind of Dairen quartzite is bluish grey to greyish white in color and has glassy appearance; it consists of quartz-grains with diam. of 0.4–0.6 mm., which are cemented together with secondary quartz grains under 0.05 mm. in diam. White granular quartzite of the same district is more crushable and very fit for the manuf. of silica brick. Under microscope, its coarse grains are 0.6–0.4 mm. large and round in shape. In reddish brown quartzite of Ryutozan, Ryojun, grains of about 0.5 mm. size are cemented with secondary quartz, about 0.03 mm. in diam., and red limonite; its refractoriness is SK 32–33, while that of the Dairen quartzite is SK 33–34. Sandstone of Chinkaiwan, Korea, chiefly consisted of round grains, 0.3–0.1 mm. in diam., is used only as mortar mat. since it is too weak. (2) Japanese quartzites. Chief quartzite producing districts are (*a*) Watsukamura in Yamashiro, (*b*) Bungo, (*c*) Tamba and Tango, and (*d*) Tosa, Awa and Iyo. Thin sections of white Watsuka quartzite show no cementing matter, solely consisting of angular quartz-grains, which are 0.8–0.2 mm. in diam. and exhibit undulatory extinction. The grains easily come off in firing. Bungo quartzite of superior quality is a red rock, finely veined with white quartz. The red portion is a mixt. of very minute grains of quartz and tuff; the white veins consist of quartz grains, 0.5–0.05 mm. large. Analysis of the quartzite is: Silica 95.19, alumina 1.03, ferric oxide 3.13, lime trace and magnesia trace. Inferior kind of Bungo quartzite, entirely or mainly, consists of coarse quartz grains, varying from 2.0 to 0.6 mm. in size. Quartzites of Tamba, Tango, Tosa, Awa and Iyo resemble those of Bungo. (3) Microstructure of domestic silica brick which have been used in a tank furnace. Outer portion of 18″ wall between ports, which has been used for 3 years, is compared with other portions with respect to chem., phys. and opt. properties.

Samples	Silica	Alumina	Ferric oxide	Lime	Magnesia	Alkalis
0–5″ from outside	94.87	1.90	1.60	1.31	0.13	0.19
0–1″ from inside	94.02	1.97	2.00	1.20	0.02	0.79

Thin sections of portion, which were 1–3″ from inside, rarely showed wedge-shaped twins of tridymite. The portion, 0–1″ from inside, contd. the wedge-shaped twins and lath-like crystals of tridymite. Thin sections prepd. from the surface of an arch-brick in a part, which had been exposed to the highest temp. in the fur., were composed of polysynthetic twins of cristobalite, 0.50 mm. long and 0.25 mm. wide, and fork-like crystals of tridymite. II. *Chamotte tank-blocks.* Chem. compns., size of grains and micro-structures of foreign tank-blocks are described. (1) Tank-blocks made by the Asahi Glass Co. Detailed descriptions on raw mats., manuf., chem. compns. and micro-structure of tank-blocks made by the Company were given. (2) Micro-structure of tank-blocks which were made by the Asahi Glass Co. and have been used in flux-line of a tank-fur. Longitudinal sections of such blocks have shown 6 continuous layers as follows:

	Outmost layer	Second layer	Third layer	Fourth layer	Fifth layer	Inmost layer
Colors	Light reddish brown	Yellowish brown	Brownish grey-black	Blackish grey	White	Brown (transparent)
Ig. loss	0.27	0.21	0.27	0.22	0.27	0
Silica	61.94	61.78	63.96	63.76	65.34	58.10
Alumina	32.82	33.00	32.41	31.63	30.29	28.74
Ferric oxide	2.55	2.74	1.96	1.74	1.32	1.59
Lime	1.11	0.70	0.72	1.39	0.73	1.04
Magnesia	0.36	0.66	0.38	0.51	0.43	0.49
Alkalis	0.94	0.91	0.30	0.75	1.63	10.04

Thin sections of the 2nd layer indicated some evidences of slight softening in the block. Those of the 3rd layer contained numerous crystals of sillimanite, 0.04 mm. long. The crystals grew up to 0.1 mm. in the 4th layer. Thin sections of the 5th layer were full of sillimanite and glass, though some quartz grains were still observed; biggest crystals of sillimanite measured 0.85 mm. in length. Some quartz grains had wedge-shape twins of tridymite in their centers. The inmost layer was nothing but a glass.
S. K.

Special brick lines. XXI. ANON. *Brit. Clayworker*, **33**, 231–2(1924).—The use of brick for iron and steel fur. ladles is discussed. H. G. S.

The Derbyshire Silica Firebrick Co.'s Works. ANON. *Brit. Clayworker*, **33**, 235(1924). H. G. S.

Handling clay automatically. ANON. *Ceram. Ind.*, **3** [6], 392–4(1924).—The plant of the Illinois Clay Products Co. located near Joliet, Ill., and operating on the Goose Lake fire clay deposit is described. Four hundred tons of fire clay are ground and screened daily by 7 men. From 50 to 100 tons of lump clay per hour are fed to an $8^1/_2$-ft. dry fan equipped with 6-T. mullers. From 35 to 40 T. of 15-mesh clay are passed through 60 sq. ft. of screening area per hr. One car of clay is loaded by one man in from 45 minutes to an hour. The plant also produces a 200-mesh product by washing. An elutriator type of classifier is used. The clay is then permitted to settle in a large tank after which it is filter pressed and dried, the capacity being 5 T. of dry product per hr.
P. D. H.

Chromite. ANON. *The Clayworker*, **82** [5], 431(1924).—The U. S. Geological Survey, Dept. of Mineral Resources of the U. S., has recently published statistics collected by EDWARD SAMPSON and H. M. MEYER, of the chromite used in the U. S. in 1923. Of our annual consumption of about 100,000 T., only a few hundred T. come from domestic sources. In the manuf. of chrome brick, the chromite is usually finely ground in a ball mill, tempered in a wet pan and dry pressed. The brick are usually dried in tunnel driers and fired in round down-draft kilns, boxed in with silica brick, to from cone 18 to 20, and slowly cooled. Because of their neutral character, chrome brick are commonly used as a parting between silica and magnesite brick. They are unattacked by iron oxide scale. The crushing strength and resist. to abrasion are low at high temps. They have poor resist. to spalling. Their fusion temp. ranges from 2050° to 2180°C.
P. D. H.

Bonding high temperature refractories. R. C. GOSREAU. *Chem. Met. Eng.*, **31**, 696–8(1924). H. H. S.

Effect of impurities in fireclays. C. E. BALES. *Brick and Clay Record*, **59**, 723–5 (1921); *J. Inst. Metals*, **30**, 699.—High-grade fire clays are those which have a chem. compn. approximating that of kaolin. B. discusses the effect of impurities. Excessive SiO_2 decreases the refractoriness and makes the finished product friable. Iron compds. act as fluxes, are coloring agents, and increase the shrinkage of clays. Ferrous Fe is extremely harmful. CaO acts as a flux, makes the brick friable (if in large lumps), and neutralizes the color produced by Fe compds. MgO acts as a flux, prevents warping, and forms a scum on the finished product. Na_2O and Mn are active fluxes. TiO_2 is a flux and acts as a coloring agent. Mn is a coloring agent. Carbonaceous matter is harmful, as it reduces Fe compds. to the ferrous condition. Excessive H_2O causes brick to crack and brings sol. salts to the surface of the brick. H. G. (*C. A.*)

Observations on requirements of refractories for open hearth. F. W. DAVIS AND G. A. BOLE. *Trans. Am. Inst. Mining Met. Eng.*, No. **1312-S**, 10 pp.(1924); cf. *C. A.*, **18**, 739.—A general discussion. C. H. K. (*C. A.*)

Materials for constructing vessels for very high temperatures. H. v. WARTENBERG. *Chem. App.*, **11**, 129–30(1924).—A summary of the properties of graphite, ZrO_2, quartz

Manchuria and Korea. Chief kind of Dairen quartzite is bluish grey to greyish white in color and has glassy appearance; it consists of quartz-grains with diam. of 0.4–0.6 mm., which are cemented together with secondary quartz grains under 0.05 mm. in diam. White granular quartzite of the same district is more crushable and very fit for the manuf. of silica brick. Under microscope, its coarse grains are 0.6–0.4 mm. large and round in shape. In reddish brown quartzite of Ryutozan, Ryojun, grains of about 0.5 mm. size are cemented with secondary quartz, about 0.03 mm. in diam., and red limonite; its refractoriness is SK 32–33, while that of the Dairen quartzite is SK 33–34. Sandstone of Chinkaiwan, Korea, chiefly consisted of round grains, 0.3–0.1 mm. in diam., is used only as mortar mat. since it is too weak. (2) Japanese quartzites. Chief quartzite producing districts are (*a*) Watsukamura in Yamashiro, (*b*) Bungo, (*c*) Tamba and Tango, and (*d*) Tosa, Awa and Iyo. Thin sections of white Watsuka quartzite show no cementing matter, solely consisting of angular quartz-grains, which are 0.8–0.2 mm. in diam. and exhibit undulatory extinction. The grains easily come off in firing. Bungo quartzite of superior quality is a red rock, finely veined with white quartz. The red portion is a mixt. of very minute grains of quartz and tuff; the white veins consist of quartz grains, 0.5–0.05 mm. large. Analysis of the quartzite is: Silica 95.19, alumina 1.03, ferric oxide 3.13, lime trace and magnesia trace. Inferior kind of Bungo quartzite, entirely or mainly, consists of coarse quartz grains, varying from 2.0 to 0.6 mm. in size. Quartzites of Tamba, Tango, Tosa, Awa and Iyo resemble those of Bungo. (3) Microstructure of domestic silica brick which have been used in a tank furnace. Outer portion of 18″ wall between ports, which has been used for 3 years, is compared with other portions with respect to chem., phys. and opt. properties.

Samples	Silica	Alumina	Ferric oxide	Lime	Magnesia	Alkalis
0–5″ from outside	94.87	1.90	1.60	1.31	0.13	0.19
0–1″ from inside	94.02	1.97	2.00	1.20	0.02	0.79

Thin sections of portion, which were 1–3″ from inside, rarely showed wedge-shaped twins of tridymite. The portion, 0–1″ from inside, contd. the wedge-shaped twins and lath-like crystals of tridymite. Thin sections prepd. from the surface of an arch-brick in a part, which had been exposed to the highest temp. in the fur., were composed of polysynthetic twins of cristobalite, 0.50 mm. long and 0.25 mm. wide, and fork-like crystals of tridymite. II. *Chamotte tank-blocks.* Chem. compns., size of grains and micro-structures of foreign tank-blocks are described. (1) Tank-blocks made by the Asahi Glass Co. Detailed descriptions on raw mats., manuf., chem. compns. and micro-structure of tank-blocks made by the Company were given. (2) Micro-structure of tank-blocks which were made by the Asahi Glass Co. and have been used in flux-line of a tank-fur. Longitudinal sections of such blocks have shown 6 continuous layers as follows:

	Outmost layer	Second layer	Third layer	Fourth layer	Fifth layer	Inmost layer
Colors	Light reddish brown	Yellowish brown	Brownish grey-black	Blackish grey	White	Brown (transparent)
Ig. loss	0.27	0.21	0.27	0.22	0.27	0
Silica	61.94	61.78	63.96	63.76	65.34	58.10
Alumina	32.82	33.00	32.41	31.63	30.29	28.74
Ferric oxide	2.55	2.74	1.96	1.74	1.32	1.59
Lime	1.11	0.70	0.72	1.39	0.73	1.04
Magnesia	0.36	0.66	0.38	0.51	0.43	0.49
Alkalis	0.94	0.91	0.30	0.75	1.63	10.04

Thin sections of the 2nd layer indicated some evidences of slight softening in the block. Those of the 3rd layer contained numerous crystals of sillimanite, 0.04 mm. long. The crystals grew up to 0.1 mm. in the 4th layer. Thin sections of the 5th layer were full of sillimanite and glass, though some quartz grains were still observed; biggest crystals of sillimanite measured 0.85 mm. in length. Some quartz grains had wedge-shape twins of tridymite in their centers. The inmost layer was nothing but a glass.
S. K.

Special brick lines. XXI. ANON. *Brit. Clayworker*, **33**, 231–2(1924).—The use of brick for iron and steel fur. ladles is discussed. H. G. S.

The Derbyshire Silica Firebrick Co.'s Works. ANON. *Brit. Clayworker*, **33**, 235(1924). H. G. S.

Handling clay automatically. ANON. *Ceram. Ind.*, **3** [6], 392–4(1924).—The plant of the Illinois Clay Products Co. located near Joliet, Ill., and operating on the Goose Lake fire clay deposit is described. Four hundred tons of fire clay are ground and screened daily by 7 men. From 50 to 100 tons of lump clay per hour are fed to an $8^1/_2$-ft. dry fan equipped with 6-T. mullers. From 35 to 40 T. of 15-mesh clay are passed through 60 sq. ft. of screening area per hr. One car of clay is loaded by one man in from 45 minutes to an hour. The plant also produces a 200-mesh product by washing. An elutriator type of classifier is used. The clay is then permitted to settle in a large tank after which it is filter pressed and dried, the capacity being 5 T. of dry product per hr.
P. D. H.

Chromite. ANON. *The Clayworker*, **82** [5], 431(1924).—The U. S. Geological Survey, Dept. of Mineral Resources of the U. S., has recently published statistics collected by EDWARD SAMPSON and H. M. MEYER, of the chromite used in the U. S. in 1923. Of our annual consumption of about 100,000 T., only a few hundred T. come from domestic sources. In the manuf. of chrome brick, the chromite is usually finely ground in a ball mill, tempered in a wet pan and dry pressed. The brick are usually dried in tunnel driers and fired in round down-draft kilns, boxed in with silica brick, to from cone 18 to 20, and slowly cooled. Because of their neutral character, chrome brick are commonly used as a parting between silica and magnesite brick. They are unattacked by iron oxide scale. The crushing strength and resist. to abrasion are low at high temps. They have poor resist. to spalling. Their fusion temp. ranges from 2050° to 2180°C.
P. D. H.

Bonding high temperature refractories. R. C. GOSREAU. *Chem. Met. Eng.*, **31**, 696–8(1924). H. H. S.

Effect of impurities in fireclays. C. E. BALES. *Brick and Clay Record*, **59**, 723–5 (1921); *J. Inst. Metals*, **30**, 699.—High-grade fire clays are those which have a chem. compn. approximating that of kaolin. B. discusses the effect of impurities. Excessive SiO_2 decreases the refractoriness and makes the finished product friable. Iron compds. act as fluxes, are coloring agents, and increase the shrinkage of clays. Ferrous Fe is extremely harmful. CaO acts as a flux, makes the brick friable (if in large lumps), and neutralizes the color produced by Fe compds. MgO acts as a flux, prevents warping, and forms a scum on the finished product. Na_2O and Mn are active fluxes. TiO_2 is a flux and acts as a coloring agent. Mn is a coloring agent. Carbonaceous matter is harmful, as it reduces Fe compds. to the ferrous condition. Excessive H_2O causes brick to crack and brings sol. salts to the surface of the brick. H. G. (*C. A.*)

Observations on requirements of refractories for open hearth. F. W. DAVIS AND G. A. BOLE. *Trans. Am. Inst. Mining Met. Eng.*, No. **1312-S**, 10 pp.(1924); cf. *C. A.*, **18**, 739.—A general discussion. C. H. K. (*C. A.*)

Materials for constructing vessels for very high temperatures. H. v. WARTENBERG. *Chem. App.*, **11**, 129–30(1924).—A summary of the properties of graphite, ZrO_2, quartz

glass, hard porcelain, Pt, Pt-Ir (30%), Ir, W and Ta, with a table showing max. temps. for use, substances by which attacked, permeability to gases, etc. J. H. M. (*C. A.*)

Action of high temperatures on some refractory substances. CAMILLE MATIGNON. *Compt. rend.*, **177,** 1290–3(1923).—The app. used was a C resistance tube-furnace, through which was maintained a current of pure N_2. The samples were in the shape of pellets placed in the center of the furnace. Temps. were read by means of a calibrated Wanner pyrometer, and correction was made for absorption of radiation by the microscope cover-glass used as a window. 1. *$Na_2O.Al_2O_3$*, made by heating Na_2CO_3 with slight excess of Al_2O_3, m. 1650°. Aluminates richer in Na_2O lose Na_2O by dissoc. below 1650°. 2. *Zr silicate.* Crystd. Brazilian zircon did not melt at 2126°. SiO_2 vapors are evolved above 1800°. The residual zircon does not melt at 2300°. Estd. m. p. 2600°. There is a possibility that zircon might be heated to give ZrO_2. 3. *Zircite.* The natural oxide did not melt at 1950°. 4. *WO_3* is reduced under conditions of expt. to metal and carbide but does not melt. 5. *AlN* does not melt at 2200°. The crystd. form is only slowly attacked by O_2 at high temps. M. O. L. (*C. A.*)

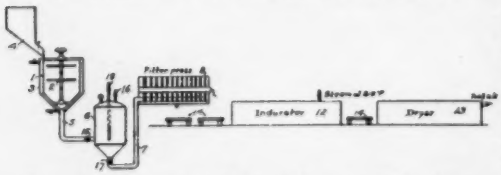
Some interesting properties of refractory materials. B. BOGITCH. *Rev. universelle mines*, **17,** 65–80(1923).—A description of the chem. and phys. properties of refractory materials, including their chem. compn. in relation to their fusibility, their phys. properties as a function of temp., and dilatation and heat condy. as a cause of their slow destruction. C. C. D. (*C. A.*)

PATENTS

Machine for making molded shapes from refractory material. CHARLES L. NORTON. U. S. 1,523,830, Jan. 20, 1925. A mach. of the class described comprising automatically actuated means moving in timed relation for molding a plastic shape in upright position upon a mold-board normally disposed below a charge delivery device; for inverting the board with the shape thereon; for restoring the board to normal position; for ejecting the shape from the molding means; and for conveying the ejected shape away from the point of ejection. A mach. of the class described comprising a mold-board and a mold-box, and a power actuated shaft provided with means for moving the mold-board and mold-box in arcuate paths, and for moving the mold-box bodily in a rectilinear path. A mach. of the class described comprising an invertible mold-box, means for inverting it, a push-plate coöperable therewith, and means for positioning the push-plate over the inverted mold-box.

Highly-refractory article. HENRY H. BUCKMAN and GEORGE A. PRITCHARD. U. S. 1,521,749, Jan. 6, 1925. As a new article of manuf. a highly refrac. mat. permanently contg. carbon in its graphitic form, and also a chem. compd. of natural zircon.

Semi-refractory heat insulating material and method of making the same. CLARK S. TEITSWORTH. U. S. 1,520,893, Dec. 30, 1924. The method of making a heat insulating compn. which consists in subjecting a mixt. comprising diatomaceous earth and lime to the action of heat and agitation in the presence of water, then molding the mixt. to desired shape and subjecting the molded mat. to the action of steam at substantially atmospheric pressure to indurate the material and subjecting the indurated mat. to a drying operation.



Porous insulating bricks. J. B. MACDERMOTT and D. A. MCLAREN. Brit. 216,771, Oct. 13, 1923. A molded material for heat- and sound-insulating purposes is prepd. from a mixt. of black peat and diatomaceous earth, in the proportions, *e. g.*, of 1 and 3 parts, resp. The material is mixed with sufficient liquid to produce a plastic mass, molded, dried and heated to about 370–425°. (*C. A.*)

Terra Cotta

Terra cotta. C. W. HILL. *The Ceramist*, **4**, 363–70(1924).—A paper prepd. for publication in the Industrial Directory of N. J. It is a brief history of the indus. The author gives also a very brief summary of the properties and advantages of the use, processes of manuf. and reference to particular examples of the type of construction. C. W. P.

Manufacture of soft earthenware. F. BIGOT. *Rev. Mat. Constr. Trav. Pub.* **182**, 249–53B(1924).—Tableware of "faience tendre" manufactured at Varages of which (1) is a chem. anal. of the fired body made of clays such as (2), (3) and (4), sand as (5) and a pure limestone. While a white body is required, plastic clays are used in which the iron oxide content helps the fusion but does not interfere with the color. At 1000° the clays give products with low porosity. The sand (5) when fired to 1050° has a reddish color, indicating the high coloring power of iron oxide in the presence of excess silica. The limestone used is a relatively pure product and acts not only as a flux but also as a decolorizer, to maintain a white product. Magnesia and dolomite have also been used for the same purpose. To obtain 100 g. of the respective oxide, 178.5 g. of $CaCO_3$ or 210 g. of $MgCO_3$ are necessary, the loss of wt. being in the proportion of 1 to 1.40. Hence the quantity of magnesia to be used is limited on account of the lack of cohesion created by the excessive porosity. To obtain similar fluxing action the magnesia mixt. must be fired to higher temps. than the lime body. In lab. expts. with dolomite B. made a tight body with compn. (12). Part of the dolomite may be substituted by a natural silicate of lime and magnesia, or by a "clinker" such as (7). Compns. (9), (10), (11) and (12) have been found to give satisfactory products. The biscuit is fired at cone 04a, and the glaze matured at cone 09a. In these compns. the sand and limestone were pure mats. With some marls the addition of magnesium oxychloride has been advantageous as a decolorizer due to the action of the chlorine. (13) is an

	(1) Fired tableware per cent	(2) Clay, per cent	(3) Clay, per cent	(4) Clay, per cent	(5) Sand, per cent	(6) Marl, per cent	(7) Clinker, per cent	(8) Dolomite, per cent
SiO_2	52.05	45.00	52.30	57.60	93.60	42.00	55.00	0.90
Al_2O_3	17.18	38.30	29.85	27.62	3.54	10.10	9.00	1.40
Fe_2O_3	1.54	0.80	1.80	1.75	1.66	4.22		
TiO_2	...	...	...	1.05	....	0.18	....	....
CaO	27.06	1.40	1.60	....	0.15	18.31	36.00	31.90
MgO		1.08	0.40	0.13	tr.	3.52		20.05
Alkalis	1.72	0.55	2.80	0.05	....	....	....	....
Ign. loss	...	12.76	10.91	11.80	1.25	(21.67)	....	46.70
TOTAL	99.55	99.89	99.66	100.00	100.20	100.00	100.00	100.95

Batch compns.	(9) Per cent	(10) Per cent	(11) Per cent	(12) Per cent	(13) Per cent
Clay (4)	40	45	45	45	..
Clay (5)	..	..	..	..	37.33
Limestone (pure)	35	40	32	..	....
Marl (6)	..	..	..	..	68.00
Dolomite (8)	..	..	..	40	12.68
Magnesium oxychloride	..	..	..	..	5.0
Sand (pure)	10	15	23	10	....
Clinker (7)	15	..	..	..	....
TOTAL	100	100	100	95	123.01

example of such a mixt. Although the iron oxide content is high the products have satisfactory color. The glazes contain either (1) Na_2O, PbO, Al_2O_3, SiO_2 and B_2O_3, with or without CaO, or (2) Na_2O, K_2O, CaO, MgO, Al_2O_3, SiO_2 and B_2O_3, a feldspathic glaze.

L. N.

Whiteware

Seven kilns do the work of nine. ANON. *Ceram. Ind.*, **3** [6], 374–9(1924).—The new plant of the Crescent China Co. at Alliance, Ohio, is fully described. The batches are weighed on a scale batch cart and delivered to double blungers, having a capacity of 6000 lbs. per 2 hrs. The slip is drawn off through a $^1/_4$-mesh screen into an agitator having a capacity of 30,000 lbs. of body. From here the slip is run over a 110-mesh rotary decagon lawn, through a sluice contg. home-made electro-magnets, and over a 140-mesh rotary lawn running at 40 r. p. m. and into a fine agitator from which it is pumped to the presses equipped with No. 10 cloth at 85 lbs. press., 105 mins. being required to fill a press. The clay is then pugged twice in horizontal pugs and delivered to the jiggermen. Nuclay used for casting is weighed up in 3500 lb. batches, ground for 12 hrs., in a pebble mill, and stored in an agitator from which it is pumped to the individual casting barrels. Each jiggerman is equipped with a continuous drier operating at a temp. of 150°F through which the ware passes in 2 hrs. and 45 min. The sagger batch is aged 3 days and pugged once. The saggers are hand-made at the rate of 130 per 9 hrs. per man. There are 3 up-draft coal fired $8^1/_2$-ft. bisque kilns each having a capacity of 2000 saggers and operating on a 7-day turnover. The ware is fired to cone 8. Veritas firing rings are also used. The dipping is done in 2 double automatic mangles operated at 135°F. There are 4—$16^1/_2$-ft. oil fired glost kilns. The ware is fired to cone 4 in 26 hrs. The ware is decorated on 3 continuous "decal" mach. There are 6-coal fired decorating kilns each 18 ft. long 9 ft. high and 3 ft. wide with 6 fire boxes. The ware is fired at 1400°F in 11 hrs. P. D. H.

Pinholes and some other things. HAROLD J. PLANT. *Pottery Gas. and Glass Trade Rev.*, **49** [570], 1989–91(1924).—Pinholes were attributed to the following causes: (*a*) the imperfect prepn. of the body mats.; (*b*) imperfect blunging; (*c*) insufficient aging; (*d*) a faulty pump, pumping air instead of clay; (*e*) bad pugging; (*f*) deleterious press cloths; (*g*) dust on the molds; (*h*) perished molds; (*i*) too much water used by the potter; (*j*) casting molds being too wet, too dry or too hot; (*k*) bad firing; and (*l*) faulty glaze mixt. P. D. H.

Porcelain. ANON. *Brit. Clayworker*, **33**, 234(1924).—Present-day methods of mfg. porcelain are described. H. G. S.

Effects of flints on the thermal expansions of some whiteware bodies. W. L. SHEARER. *The Ceramist*, **4**, 143–65(1924).—An investigation of the effect of (*a*) quartz rock; (*b*) quartz sand; (*c*) quartz sand rock; (*d*) flint rock; (*e*) cryptocryst. quartz (chert); (*f*) French pebbles; (*g*) French pebbles; (*h*) quartz sand-rock, finely ground; (*i*) cristobalite from a fired silica brick upon semi-porcelain vitreous china and sanitary bodies. These bodies when fired were studied with reference to their thermal expansion dunting and quenching conduct. In the semi-porcelain body, the (*a*), (*b*), and (*c*) had practically identical influence; (*h*) showed a consistently higher coeff. The cristobalite (*i*) gave a more rapid expansion up to 250° and slower thereafter. A similar body prepd. with cryptocryst. mat., French and domestic, showed but slight difference between the same. A comparison of the 3 bodies using (*b*) shows that the vitreous body has a uniformly slightly higher rate than the others. At 400° the semi-porcelain body begins to show an accelerated rate and it overtakes the vitreous body at about 550°. A comparison of the effect of ground sand, rock flint, cryptocryst. quartz and French flint in a vitreous body shows a slightly increased expansion up to 250° in the case of the ad-

dition of French flint which is attributed to the development of cristobalite. The same body shows a slightly diminished expansion at 600°. The other bodies are quite similar in their conduct. The addn. of (*b*), (*c*), (*d*), (*e*), and (*g*) to sanitary ware body showed little differences in the expansion conduct. Dunting tests were conducted by means of cups which were htd. in a fur. and allowed to cool to room temps. Failure was attributed to the inversion of α quartz to the β quartz. Dunting is dependent upon the rate of cooling. It is difficult to produce dunting in the semi-porcelain body containing cristobalite. Bodies contg. cryptocryst. quartz or true flints are more resistant to dunting than the bodies containing quartz. A finely ground "flint" produces a body more resistant to dunting. These conclusions are restricted to vitreous china and sanitary ware. Porous ware seems to have the same tendency to dunt as the more vitreous wares. Quenching tests were conducted by htg. disks measuring $3^1/_2$" in diam. x $^1/_2$" thick to uniform temp. of 200° and plunging them into water at room temp. Semi-porcelain bodies are more resistant to failure than the sanitary or vitreous china. The various siliceous mats. may be listed in the following order with respect to their effect in bodies on resist. to quenching, the first named giving the greatest resist.: sand (*b*), rock (*a*), rock sand (*c*), French pebbles (*f*), ditto (*g*), cryptocryst. (*d*). There is no very sharp line of demarcation. In general bodies contg. regular quartz flints are better than those contg. cryptocryst. flints. C. W. P.

Practical aspects of the casting of heavy vitrified clay products. C. C. TREISCHEL. *The Ceramist*, **4**, 204–10(1924).—Amount of ball clay used varies from 5–25 per cent depending upon their characteristics. It is good practice to use two kinds. For heavy vitreous wares, Am. ball clays are equal if not superior to imported. A factory method of testing the colloidal content is to slake 100 grams of ball clay with 200 grams of water and let stand 48 hrs. in long narrow tube. The degree of turbidity is index of colloidal content. Substitution of Am. secondary kaolin, such as those from So. Car., Ga. and Fla., for English kaolin will cause trouble. Am. clays may be used but the bodies are characteristically different. Casting slips may be either premixed or raw. The first are blunged and filter pressed, and are added to the water and electrolytes. The raw slips are prepared by mixing the body mats., salts and water. In this latter case the general practice is to mix in a ball mill. Premixing has the disadvantage of removing certain organic compounds which are deflocculating agents. Otherwise, neither method has any advantages. Slips used for core casting should weigh 30 ozs. to the pint and more. Slips for drain casting should weigh about 28 ozs. to the pint. The author recommends adding $^3/_4$ of the necessary amt. of electrolytes to the water in the blunger or ball mill. To this is added the body materials and finally the remainder of the salts. Care must be exercised in testing the weight and viscosity of the slips. The storage of casting slips is important because it affords an opportunity to free the slip from as much air as possible. The proper construction of the blades of the agitator as well as suitable speed accomplish this result. A thickening of the slip on standing is attributed to adsorption of the salts by colloidal mat. C. W. P.

Practical aspects of casting heavy vitrified white ware products. (Continued.) C. C. TREISCHEL. *The Ceramist*, **4**, 283–6(1924).—*Mold and mold-making.* The body of the mold, for use in casting, should be more dense than the core. Sharp corners and unequal thicknesses cause sticking and mold cracking. Molds may be classified as (*a*) molds for core casting, (*b*) molds for draining and (1) open-top and (2) closed-top. The closed-top mold requires the use of a funnel for introducing the slip and laminations formed at that point. Slip distributed by continuous pumping will probably fluctuate in viscosity due to heat generated by friction. Author unable to state whether or not this is objectionable. To avoid sticking of the body to cores the following methods are used: (*a*) wrapping the core in cheese cloth, (*b*) dusting the core with talc, flint, whiting

or dry body, (*c*) the admission of air under pressure through the plaster cores. The assembling or "sticking up" to form the completed piece may be done with (*a*) water, (*b*) slip, (*c*) wads, (*d*) glaze. C. W. P.

Manufacture of electrical porcelain at the plant of Pass and Seymour. R. F. SHERWOOD. *The Ceramist*, **5**, 74–91(1924).—A description of the operation employed in the manuf. of low tension elec. insulators which does not differ materially from the processes customarily used. C. W. P.

Sanitary ware industry in America, historical and statistical with a brief reference to the technology. LEROY H. MINTON. *The Ceramist*, **4**, 337–50(1924). C. W. P.

Permanent filter mats in Gooch crucibles. O. R. SWEENEY AND G. N. QUAM. *J. Am. Chem. Soc.*, **46**, 958–60(1924).—Porcelain from a crucible of the same brand as that used for the test was crushed and graded into Grades I, through 130-mesh; II, through 64-mesh; III, through 0.5 mm.; and IV, through 1.0 mm. Grade IV was used to fill perforations in the crucible, and then a mixt. of Grades III, II and I in the proportion of 2:2:3 was added to a depth of 6 to 7 mm., treated with 0.5 *N* KOH soln. satd. with $Ca(OH)_2$, dried at 110° for 10 hrs., heated in full flame of a Meker burner 2 to 8 hrs., and then extd. with 50 cc. 6 *N* HCl, washed, heated until no Na flame was visible, extd. with HCl (sp. gr. 1.2), again heated, treated with aqua regia repeatedly, dried at 110° and weighed. Such crucibles permitted 1.45–2.94 cc. of H_2O per min. to flow through (when crucible was kept filled with H_2O), and removed $BaSO_4$ and AgCl ppts. satisfactorily. Superiority of porous crucibles is claimed. W. C. E. (*C. A.*)

The properties of high tension (porcelain) insulators. M. F. DAHL. *Electrotechn. Maschinenbau*, **42**, 361–6(1924). C. F. G. (*C. A.*)

Equipment and Apparatus

A recording apparatus for the measurement of the expansion of glass. A. ARNULF. *Sci. Abstr.*, **27** [11], 995(1924); *Rev. d'Optique*, **3**, 270–6, June, 1924.—The paper gives details of an app. for obtaining a continuous record of the expansion of samples of glass of thin dimensions. An interference method is employed, derived from that of FIZEAU, and as the expansion is measured directly, the need for a standard body for purposes of comparison is dispensed with. The displacements of Newton's rings, formed between two surfaces, one spherical and the other plane, sepd. by an annular wedge of the specimen under examination, are registered and then counted. The registration of the displacements of the rings is accomplished by projecting them on to a slit, placed initially over their center, and across which a photographic plate is drawn in a direction perpendicular to the length of the slit. Initially, the record on the plate consists of parallel lines, but as the temp. is raised the rings are displaced, the lines become curved, and eventually meet at the point of disappearance. These points are well marked on the record and by detg. the number of such points for a given rise of temp., the exact expansion can be detd. The app. is enclosed in a box around which a htg. coil is wound. By passing a current through this coil temps. up to 300°C are obtained. A mercury lamp furnishes the source of monochromatic light. The paper concludes with a detailed description of the app., and directions, precautions, etc., for its use. A sample can be completely examd. in half an hour. A. F. G.

Double mirror dilatometer for low-temperature work. G. BORELIUS AND C. H. JOHANSSON. *Sci. Abstr.*, **27** [11], 995(1924); *Ann. D. Physik*, **75** [1], 23–36 (1924).—A brass plate resting on two supports has a pair of parallel mirrors fixed one at either end. The specimen under test is fastened rigidly at its upper end while its lower end is attached to the center of the brass plate. As the specimen expands or contracts, this plate is bent and the amt. of bending is detd. in the usual way using a beam of light reflected from the mirrors in turn. The variation of angle between the

mirrors depends only on their distance apart and the amt. of bending of the plate. The whole app. is enclosed in a chamber and the temp. is varied by the use of liquid air and measd. by a platinum thermometer. The range is down to about −200°C. Some results are given for specially pure copper rods and also for crystals of zinc and cadmium in various directions relative to the axes. A. F. G.

Diamond fishtail bits. ANON. *The Clay Worker*, **82** [3], 223(1924).—The bits are made of special alloy steel, heat treated and give several times the service of the old blacksmith bit. They range in diam. from $1^1/_2$ in. to $3^3/_4$ in. They cost but a few cents and can be attached to the old auger by simply flattening the end of the auger and drilling a hole for the bolt. The speed of shot hole drilling is doubled. They are manufactured and distributed by the Jos. McLaughlin Co. of Joliet, Ill. P. D. H.

Ball and tube mill liners. WILLIAM T. W. MILLER. *Eng. and Min. Jour.-Press* **118** [16], 613–7(1924).—A discussion is given on the linings used in ball and tube mills. In the early days flint pebbles were largely used as the grinding media and the lining of the mill was also made of silica in either natural or artificial blocks. In some industries, as the pottery trade, the silex lining is still in use but such instances are now exceptional, and the use of alloy steel or iron linings has become the general practice. A. H. K.

Domestic tube mill lining successfully meets foreign competition. W. M. WEIGEL. *Eng. and Min. Jour.-Press*, **118** [24], 925–8(1924).—A detailed discussion is given on the mining of quartzite rock at Jasper, Minn. Lining blocks and grinding pebbles are produced. In mining and cement industries, iron and alloy steel linings and balls have largely replaced flint linings; but in the grinding of silica, feldspar, whiting and glazes for the ceramic industry, flint or porcelain liners are necessary. The chemical analysis and the physical tests made on the Jasper quartzite are as follows:

Silica as quartz	94.00%
Silicates of alumina and potash	2.40%
Hydrous silicate of lime	2.00%
Iron oxide	1.60%
Crushing strength, pounds per square inch	45,300
Abrasion by standard rattler test	4.6 %
Toughness, French coefficient	21.5 %

A. H. K.

Calorimetric apparatus for the measurement of reaction heats at high temperatures. J. D. DAVIS. *Ind. Eng. Chem.*, **16,** 726–30(1924).—The app. consists of an adiabatic twin calorimeter of the const.-vol. type provided with means of electrically heating the substance under test in steel bombs similar to those used in combustion calorimetry. The reaction is carried out in one bomb while its twin receives the same amt. of elec. energy. The capacities of the 2 calorimeters are equal; hence the reaction heat sought is the difference between heat quantities developed in the two as measured calorimetrically. Calorimetric precision realized was 3.6% of the heat quantity measured or 0.013% of the total involved, which last includes the heat used electrically. Results for the *heat of carbonization of coal* are given and the theory of the twin calorimeter is discussed. J. D. D. (*C. A.*)

Design and operation of ball and pebble mills. E. W. LAWLER. *Chem. Met. Eng.*, **30,** 517–8(1924).—The main factors involved in non-continuous ball or pebble mills are: for mill design—shape, proportions, lining and discharge openings; operating factors, size of feed, feed load, kind, shape, size and load of balls or grinding media, wet or dry grinding, speed of mill and time of grind. A pebble mill is a pulverizer rather than a crusher. Pulverizing can best be done by attrition instead of

by impact. The time of grinding is detd. best by counting revolutions rather than by actual time. W. H. B. (*C. A.*)

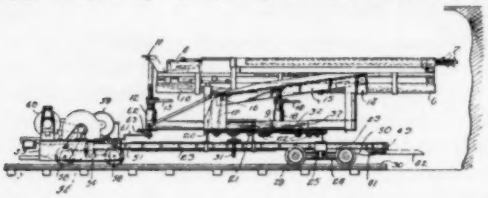
Supplemental theory of fine grinding. A. T. Fry. *Chem. Eng. Mining Rev.*, **15**, 388–94(1923).—In grinding material in a ball mill it was discovered that at a certain point of time a very marked loss in efficiency occurred. This is intimately related to the angle of nip (approximately 30°), as in the case of roll crushing. For a given diam. of flint one can calc. the diam. (d) of the contact area which would result were the feed composed of a particular size (P), and for a given number of flints of a certain av. diam. the available contact area for crushing depends on the size of the feed particles available up to the max. permitted by the angle of nip. Thus, the max. diam. of particle nipped (angle of nip = 30°), $P = 0.07R$, where R = radius of the flint; and the diam. of the contact area, $d = 2(\sqrt{RP + (P^2/4)} - 0.00907\,R)$. As the contact area is diminished the energy of impact will be concd. on an area too small to hold sufficient rock to absorb the energy efficiently in the resulting comminution; therefore, the smallest effective flints should be used, and still smaller steel balls may be preferable. Exptl. results are reported showing the relationships among above factors, energy consumption, etc. W. C. E. (*C. A.*)

The selection and care of pyrometers. J. W. Conzelman. *Power*, **58**, 644–6 (1923).—Details are given for the making and use of thermocouples. D. B. D. (*C. A.*)

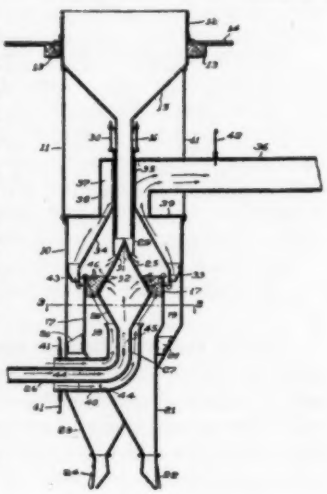
High-frequency electric induction furnace. R. Dufour. *Compt. rend.*, **176**, 828–30(1923).—The uses and advantages of high-frequency induction furnaces are briefly discussed. C. C. V. V. (*C. A.*)

PATENTS

Mining machine. Ralph E. Noble. U. S. 1,521,788, Jan. 6, 1925. A mining app. comprising a propelling truck, a trailer truck, a vehicle frame pivotally mounted on said trailer truck and connected to the propelling truck by a swivel connection, a turn-table on said vehicle frame, and a mining mach. adjustably mounted on said turn-table.



Pneumatic classifier. Albert H. Stebbins. U. S. 1,522,151, Jan. 6, 1925. A pneumatic classifier, comprising, in combination, a closed casing, an annular sepg. wall disposed centrally within said casing and extending upwardly therein to form an inner and an outer chamber within the casing, a second annular wall within the casing extending downwardly in spaced overlapping relation about the upper end of the separating wall, an air conduit extending upwardly within the inner chamber, an upwardly extending cone within the inner chamber supported over said conduit so that mats. sliding down the walls of the cone will not enter the conduit, means for delivering mats. to be treated to the cone, and means for exhausting air from the upper portion of the casing about said second wall to produce air currents that rise within the inner chamber and pass upwardly over the end of the sepg. wall and downwardly about the end of the second wall to remove the lighter particles from the heavier particles.



Kilns, Furnaces, Fuels and Combustion

Magnetic recovery of combustible in boiler plant refuse. RUDOLPH KUDLICH. *Jour. Franklin Inst.*, **198** [6], 835–6(1924).—The amt. of unconsumed combustible in boiler refuse may range from a few per cent to as high as 40 to 50%. Recovery on the magnetic principle has proved satisfactory. Tests reported by a German firm using a magnetic type separator showed recoveries up to 87% of the combustible in the refuse. From a standard magnetic separator an American firm was able to recover approx. 50% of the combustible. A. H. K.

The tunnel kiln. ANON. *Brick and Clay Rec.*, **66** [1], 22–36(1925); and *Ceramic Industry*, **4** (1), 38–52(1925).—These articles are practically identical with the exception that the article in *Brick and Clay Record* contains, in addition, a section on the history of the tunnel kiln, both foreign and domestic, together with a partial bibliography on tunnel kiln. A description of the different types of tunnel kilns, the advantages and disadvantages, the principles of opern., the operg. information on 20 kilns now being used and a list of practically all of the tunnel kilns in the country, are thoroughly covered. *It is the most complete treatise on the subject of tunnel kilns that has ever been presented.* P. D. H.

New kiln proves fuel saver. ANON. *Ceram. Ind.*, **3** [6], 386–7(1924).—The kiln described is one recently installed by the A. P. Green Fire Brick Co. of Mexico, Mo. The kiln is of the rectangular down-draft type with a flat crown. The dimensions are 24 x 36 x 9 ft. from the floor to the crown. The crown is of the Liptak single suspension type, such as is extensively used in boiler arches. Twelve 15-inch "I" beams, which rest on the side walls of the kiln, support the entire crown. The crown blocks were made with a long neck so as to permit of $4^1/_2$ in. of insulation. There are 8 vent holes 12 in. square in the crown, to facilitate cooling. The side wall construction consists of a 13-in. lining with $4^1/_2$ in. of insulation and facing. The whole structure is covered with a galvanized tin roof. There are six 24-in. inclined grate bar fur. on either side and two 15-in. fur. of the same type at either end, located on either side of the wicket. The ratio of grate area to floor area is 1 to 11 and has been found ample. The ironing is composed of four 6-inch "I" beams for buckstays at either side and at either end of the kiln with the usual tie rods. There is a $4^1/_2$ in. continuous bag wall which is 9 in. from the kiln wall and extends to within 3 ft. of the crown. The brick in the bag wall are placed "checker" fashion with approx. 6 sq. in. between them. Behind the bag walls and at either side of each fur. are supporting piers, built in open style, which tie the bag wall to the main kiln wall. This construction affords a uniform draft through the kiln as evidenced by the even ht. distribution from top to bottom. The draft during the water-smoking period is good and the kiln is fired off in less time and with less coal than a round kiln of equal capacity. The quality of ware is exceptionally good. The other advantages of this type of kiln are: greater setting capacity, elimination of crown thrust, crown repairs facilitated, more effective combustion of gases from fur., and the ease with which the crown can be protected by a roof. P. D. H.

Ash softening temperature and clinkering of coals in a boiler furnace. J. F. BARKLEY. Repts. of Investigations, *Bur. Mines*, Serial No. **2630**(1924).—A table is given showing the chem. anal., ash softening temps., softening intervals, flow intervals and fur. conditions in connection with a number of coal samples. There appears to be a general relationship between the ash softening temps. and the clinkering in the fur. P. D. H.

Calculation of equivalent orifice for kiln drafts. PIERRE DE GROOTE. *Rev. Mat. Constr. Trav. Pub.*, **181**, 209–13B(1924).—From the consumption of coal fuel per hr., knowing the ash and CO_2 content, Q the flow of gas in cu. m. per sec. can be calcd. for $t°$ the av. temp. of the gas in the kiln, obtained by measg. the temp. of the gas at the

outlet of the fire-box and at the stack. With the measured quantity r the resist. of the kiln in mm. of water obtained by a pitot tube in the draft system, the following relationship exists between the terms:

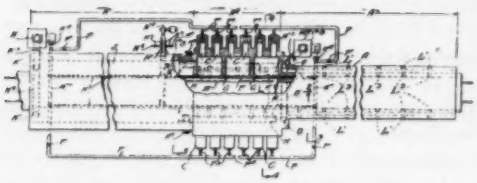
$$a = \frac{Q}{0.65\sqrt{15.17\,\frac{r}{1.04}\left(1+\frac{t}{273}\right)}}$$

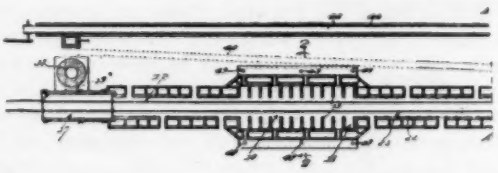
where a is the equiv. orifice of the kiln in sq. m., that is, an orifice which gives the same resist. to the vol. of heated gas as exists in the kiln. The term r includes a correction, namely the addition of 1 mm. for each m. of height the crown of the kiln is above the surface of the grate. A graphic chart is given whereby a or Q is detd. by inspection from values of r and t. L. N.

A study of the destructive distillation of coal. EDWARD VICTOR EVANS. *Jour. Royal Soc. Arts*, **72** [3749, 3750, 3751], 767–82, 785–801, 805–18(1924).—*Lecture 1.* A discussion on the efficiency of high and low temp. carbonization and the thermal value of the products. The design of retorts is briefly considered. Vol. and calorific curves are given showing the effect of high vacuum and the rate of gas production. The effect of leaks in retorts is also shown by gas curves. *Lecture 2* brought out the fact that rapid carbonization is essential to the best yields of gaseous therms. This result is considered due to reason that the tar is subjected to a higher degree of cracking with the result that gas is produced at the expense of tar. *Lecture 3* considers the question of how to modify the carbonizing process in order to increase the rate of heat transmission not only through the retort walls but also through the charge itself. High heat transmission through the retort walls is obtained by the use of carborundum. High heat transmission through the charge was obtained by mixing coke with the coal. A study was made of the carbonization of briquetted coal and the results showed a greater production of gas per ton of coal and the resulting coke was found to burn to an ash practically free from carbon. E. J. T.

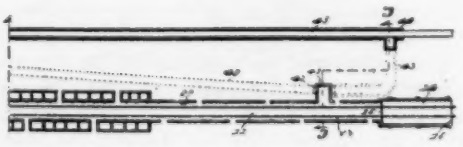
PATENTS

Combination open and muffle kiln and method of operating the same. HARRY M. ROBERTSON. U. S. 1,521,392, Dec. 30, 1924. The method of treating ceram. ware which consists in gradually heating the ware to a high temp. by passing the ware through a continuous tunnel kiln comprising a htg. up zone in which the ware receives the major portion of its heating and in which an oxidizing atmosphere is maintained, and a successive kiln zone in which further heat is supplied to the ware and the latter is subjected to a non-oxidizing atmosphere by contact with hot gases passed into the kiln chamber at its top and withdrawn from the kiln chamber at its bottom.



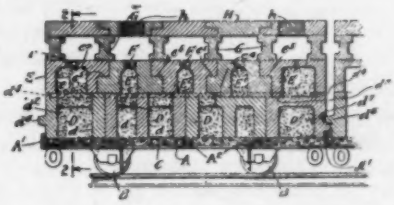


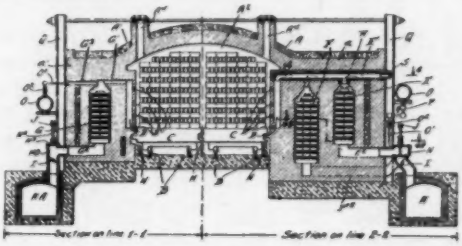
Combined brick kiln and drier. NICHOLAS U. LUDWIG. U. S. 1,523,485, Jan. 20, 1925. In a kiln for firing brick, a tunnel, firing chambers on each side of the tunnel, superimposed checkered



brick in each chamber, the inner edges of the courses of the brick being stepped outwardly toward the top, the flues formed by the checkered arrangement of the brick being gradually higher from the inner edge to the outer wall of the said chamber, and means for generating heat under the checkered structure.

Kiln car. PHILIP D'H. DRESSLER. U. S. 1,521,216, Dec. 30, 1924. That the refrac. blocks composing the refrac. body portion of the car are much larger than have heretofore been employed in the construction of such car bodies. As a matter of fact the blocks in the construction shown, are as large as it is ordinarily feasible to make them.





Kiln and method of operating same. LOUIS WILPUTTE. U. S. 1,522,166, Jan. 6, 1925. The method which consists in causing a gaseous thermal agent to move through a tunnel kiln chamber with a direction of flow which at all points in the kiln chamber is approx. horizontal and transverse to the length of the kiln.

Geology

The geology of the clay deposits with particular reference to those in New Jersey. W. W. TWITCHELL. *The Ceramist*, **4**, 211–28(1924).—The formation of clays and distribution and geological history of the chief clay deposits in N. J. C. W. P.

Marketing of fullers' earth. ARTHUR B. PARSONS. *Eng. and Min. Jour.-Press*, **118** [20], 771–3(1924).—The properties, production and composition of fullers' earth are discussed. The value of this earth is due to its unusual proficiency in absorbing basic coloring matter, from oils of vegetable, animal and mineral origin. The U. S. virtually has a monopoly of the production of this earth. Further progress will depend largely on improvements in technical control of production and prepn. A. H. K.

Visit to the kaolin quarries of the region d'Echassières, Allier (France). ANON. *Rev. Mat. Constr. Trav. Pub.*, **181**, 220–7B(1924).—An interesting article written by the ceram. students of Vierzon-Ville, of their trip to the kaolin quarries. It includes a map of the district, general plans and layout of the three different quarries. At the Beauvoir quarry, kaolin is worked with pick and shovel, whereas at Chaunes Molles and Colettes the kaolin is washed down by heavy streams of water. The kaolin was produced by the weathering of granite contg. quartz, feldspar and white mica. It is used in the manuf. of porcelain, faience, paper, etc. The usual methods of settling out the coarse and fine sand, bluing with methylene blue, concentrating and drying of the slip are also given. At Beauvoir the "rose" quarry is noted for its content of cassiterite, occurring in the sand. The cassiterite is concd. from the quartz by means of vibrating tables, and put on the market. Before the war tantalo-niobiate of iron and manganese were concd. from the same source, and used as a raw mat. for tantalum filaments. L. N.

Chemistry and Physics

Properties of powders. Influence of velocity of compression on apparent compressibility. Part VIII. E. E. WALKER. *Sci. Abstr.*, **27** [11], 946(1924). (*Trans.*

Faraday Soc., **19**, 614–620; *Disc.*, 620–2, March, 1924.)—When a powder is compressed in a cylinder by a constant load the velocity of compression is very high at first and then rapidly falls off. The relationship between the length of time for which the load has been applied and the velocity with which compression takes place is calculated from the equation

$$\text{Velocity of compression} = -\frac{dV}{dt} = K't^{-0.9}$$

Where V is vol. ratio, t the load, and K' the velocity coeff. The author calculates the relationship between the resist. which a powder offers to compression by impact of known velocity (R_i) and its resistance to a static load of known duration (R_p) from the equation $\log_{10}\frac{R_i}{R_p} = 10\frac{K'}{K}\left\{t^{\frac{1}{10}} - \left(\frac{K'Q}{5v}\right)^{\frac{1}{9}}\right\}$ where v = impact velocity of falling weight in cm./sec., Q = quantity of powder in cu. cm., and gives the results in a table. The case of powdered ammonium nitrate is fully discussed, and figures are given to demonstrate that it is quite liable to shrink under the influence of prolonged external pressure and when acted upon by capillary forces. In the *Discussion*, E. P. PERMAN states that as a result of expts. he found the following: (1) No moisture, no shrinkage; (2) rapid increase of shrinkage with increase of moisture; (3) the greater the soly., the greater the shrinkage. A. F. G.

Thermoelectric investigation of nickel alloys. W. ROHN. *Sci. Abstr.*, **27** [11], 1013(1924). (*Zeits. f. Metallkunde*, **16**, 297–300, Aug., 1924).—The object of this investigation was to obtain a thermocouple suitable for commercial use up to temps. in the neighborhood of 1200°C. The mats. for such a couple should be cheap, durable, and the thermoelec. force should be reasonably high so as to avoid measg. instruments of greater sensitivity. With this object in view, an investigation of the variation of the thermoelec. force of the metals Ni, Co, Al, Mg, Fe, Ta, Au, Cu, Ag, Mo, and W with Pt as the other element of the couple was first carried out over the range of 0–1200°C. The results are represented graphically in the paper, and it is concluded that Ni is the most suitable metal to employ as base for an alloy. Measurements were then made of the thermoelec. force, over the same temp. range, of Pt with binary alloys of Ni. The alloys used were Ni with 5% of Al, Mn, Ti, Ta, Zr, W, Mo, Cr, and V, and 10% of Cu, Co, Fe, W, Cr, Mo, and V. The data are represented graphically. From these curves it is deduced that combinations of Ni with Ni-Al or Ni-Cu or Ni-Fe might be used for ranges beyond 500°. For wider ranges combinations of Ni-Va, Ni-Cr, Ni-Mo or Ni-W, with either pure Ni or Ni-Al or Ni-Cu would be suitable. Va is excluded on account of the technical difficulty of obtaining it sufficiently pure, and Ni-Al alloys with more than 5% Al are difficult to prepare. Then follows an investigation of the electromotive force of couples formed of Ni with 4, 8, 10 or 16 parts of Cr, 4, 8, 10, 12, 16 or 20 parts of Mo or W, and 10, 30, 50 or 70 parts by weight of Cu against pure Pt. From the curves coördinating these data it is inferred that suitable couples would be Ni-Mo (16% Mo) against Ni-Cu (Cu 50%). No. 1 in figure. Oxidation, however, sets in rapidly beyond 800°C. No. 2 represents Ni-Cr (9.5% Cr) against Ni. No. 3 (full line) is the usual Pt Pt-Rh couple, and the broken line 4 is a combination of two Ni-Cr alloys giving almost the same thermoelectric force. A. F. G.

Quantitative analysis of glass. JUSEI SUGIE AND OTOJI HATAYAMA. The Osaka Indus. Lab., *Bull.* **5** [3], 22 pp.(1924).—Methods of analyzing ordinary crown, borosilicate crown, barium crown, ordinary flint and barium flint are described in detail and the authors propose them as the standard methods in the country. S. K.

Preparation of titanium oxide and its refining. TAMAKI MATSUBARA. The Osaka Industrial Laboratory, *Bull.* **4** [13], 16 pp.(1923).—Recently, a titanium ore was found

in Korea. An analysis is: Titanium oxide 25.90, silica 4.58, ferric oxide 58.85, alumina 1.10, lime 4.08 and magnesia 3.60. Titanium oxide was prepd. by the known method, in which titanium-bearing ores are decomposed with conc. sulphuric acid. The results indicate that the ore must be ground as finely as possible, and also that too much excess of sulphuric acid reduces the yield of titanic acid. Various processes of refining the crude oxide have been experimented. Dehydration of refined titanic acid at temp. over 400°C is injurious, since yellowish tints are produced. S. K.

Absorption of H_2S from gas. ANON. *Chem. Trade Jour. and Chem. Eng.*, Sept. 19, 1924.—Dry purification by hydrated iron oxide used with a liquid process which employs a dil. soln. of sodium carbonate. The H_2S is removed from the soda soln. by aeration and is then used over again. The liquid process may be used for complete purification but is usually used to remove 85 to 90% of the H_2S and the remainder taken out by iron oxide catch boxes. The process also removes 90% of the HCN. E. J. T.

Colloid chemistry. ERICK RIDEAL. *J. Roy. Soc. Arts*, **72** [3752, 3753, 3754], 830–6, 838–44, 849–54(1924).—Three lectures on colloid chemistry. *Lecture 1* deals with the phenomena of adsorption, surface tension and catalysis. *Lecture 2* is devoted to the consideration of the suspension colloids in which a solid phase is finely dispersed in either a liquid or gaseous dispersion medium forming sols and smokes, respectively, and the difference in the properties of such a disperse system from the solid mat. one due to the operation of surface forces. *Lecture 3* deals with emulsions and gels. A great number of tech. and indus. applications are cited in all the lectures. E. J. T.

Critical studies on methods of analysis—XII. Boron. LEON A. CONGDON AND J. M. ROSSO. (Contribution from the Dept. of Chemistry, Syracuse University.) *Chem. News*, **129,** 3365(1924).—A comparative study of different methods for the detn. of boron. The sample used with all methods was C. P. boric acid contg. a trace of sodium. The study of these methods for boric acid shows that their accuracy can be classified as follows, the most accurate coming first: (1) DUNSTAN'S volumetric neutralization process with addition of glyceral; (2) GOOCH'S distillation gravimetric $CA_3(BO_3)_2$ method; (3) ASHMAN'S distillation gravimetric phosphate procedure; 4th, DITTE'S gravimetric $CA_3(BO_3)_2$ method. Dunstan's method is the quickest as well as the most accurate. E. J. T.

Elementary science in relation to clayworking. VI. ANON. *Brit. Clayworker*, **33,** 225–6(1924).—The detn. of lime in clays is described. H. G. S.

Separation of molybdic and tungstic acids. I. KOPPEL. *Chem. Zeit.*, **48,** 801–2 (1924); *J. Soc. Chem. Ind.*, **43B,** 1030(1924).—The alkaline soln. contg. molybdate and tungstate is neutralized with formic acid and treated with a few cc. of amm. sulphide soln. The liquid is diluted to 100 cc., 5 cc. of strong formic acid are added, and the mixt. is htd. until molybdenum sulphide coagulates and settles. The filtered ppt. is washed with dilute formic acid and gently calcined to oxide. The filtrate is evaptd. with H_2SO_4 and tungstic acid pptd. by hydrolysis. H. H. S.

Binary system $Na_2O.SiO_2$–SiO_2. G. W. MOREY AND N. L. BOWEN. *J. Phys. Chem.*, **28,** 1167–79(1924). H. H. S.

New reactions for the detection of ruthenium and osmium. L. WÖHLER AND L. METZ. *Z. anorg. Chem.*, **138,** 368(1924); *Jour. Soc. Chem. Ind.*, **43B,** 998(1924).—Thiocarbanilide and HCl give blue-green with Ru, and red with Os solns. Both colors can be extracted with ether, and are delicate to 3 in 10 million parts. H. H. S.

Sodium alizarate and alumina. F. S. WILLIAMSON. *J. Phys. Chem.*, **28,** 891–2 (1924).—Hydrous *Al(OH)*$_3$ and *Na* or *NH*$_4$ *alizarate* when mixed give an adsorption complex and not a definite *Al alizarate* because no base is liberated in the reaction and the nature of the product formed varies with the conditions of the expt. A. G. (*C. A.*)

Modification of the Grosvenor humidity chart. G. C. GREENFIELD. *J. Soc.*

Chem. Ind., **43**, 9–10T(1924).—Because of changes in vol. with temp., relative humidity, as commonly used, is not on a const. basis. GROSVENOR's humidity is defined as lbs. H_2O vapor per lb. dry air. This is directly comparable but applies to air only. Greenfield's modification expresses humidity as lbs. H_2O vapor per lb.-mol. of dry gas. This eliminates the former's method requiring gas analysis or mol. wt. detn., and applies to all gases. The data given are important in air-conditioning, drying, and cooling problems involving heat transfer. Definitions and a humidity chart for air are given.
A. R. A. (*C. A.*)

Effect of the concentration of colloidal clay upon its hydrogen-ion concentration. RICHARD BRADFIELD. *J. Phys. Chem.*, **28**, 170–5(1924).—A fresh acid clay soil was churned with distd. water, allowed to settle and the muddy suspension was centrifuged several times. From the clear centrifuged soln. colloidal material was obtained by the prolonged application of high centrifugal force. This colloidal material was dild. with water until at a concn. of 12.8% it became a thick sirup. This soln. and more dil. solns. were examd., for their p_H values by the potentiometer method. The relation between the concn. of an acid colloidal clay and its H-ion concn. is practically linear at higher diln. (0–0.4%), exponential at intermediate dilns. (0.49–3.5%) and practically const. at higher concns. (3.5–12.8%). The curve of the acid colloidal clay and that of AcOH are so similar in every respect that it seems highly improbable that the acidity in the case of the former is due to the preferential adsorption of the OH-ion and in the case of the latter to true acidity. The differences in the Sörensen values yielded by the 2 acids are probably due to differences in their strength, the colloidal clay acid being a much weaker acid than AcOH. The fact that one is colloidal and the other crystalloidal is due merely to differences in the complexity of their mols. and not to any fundamental difference in the nature of their acidity. J. M. B. (*C. A.*)

Heat of formation of sodium silicate. CAMILLE MATIGNON. *Bull. soc. chim.*, **35**, 29–31(1924).—Na_2SiO_3 in soln. was decomposed by HCl, the heat of combination of Na_2O and *hydrated* SiO_2 was thus found to be 51.10 cal. If this result is compared with TCHERNOBAEFF's, 45.2, obtained with anhydrous SiO_2, it would seem that heat is absorbed in the hydration of SiO_2. M. thinks there is a mistake somewhere. MULERT's result, 69.7, he rejects as too high, because it is about equal to the heat of formation of Na_2CO_3, while the analogy of the compds. of Ca and Fe indicates that the heat of formation of the metasilicates should be lower than of the carbonates. W. P. W. (*C. A.*)

A new application of the bar method for the measurement of thermal conductivity. MARCUS O'DAY. *Phys. Rev.*, **23**, 245–54(1924).—The bar method is defined as that, originally suggested by KOHLRAUSCH and employed by JAEGER and DIESSELHORST, where the condy. measured is that of a bar of metal, electrically heated, and running between blocks at const. temp. The mathematical treatment includes 2 methods, one due to CALLENDAR, one apparently original, by which some of the disturbing effects are balanced against each other and so made to vanish. The precision, that is, the completeness, with which this was done was not estimated, nor was the accuracy of the final results. For Pb the condy. was found: at 0°, 0.0877; at 26.5°, 0.0920; at 53.1°, 0.0955. For Sn at about 25°, 0.1575. The method can be modified to measure the *Thomson effect*, and is about 10 times as sensitive as most other methods. An effect of 0.4° in about 150°, or 3 per mille was obtained, giving $S = 9.7 \times 10^{-7}$ cal. per coulomb per sec. at 38° for Sn. W. P. W. (*C. A.*)

Comment on the principle of a general method for determining the heat capacity of solids and liquids and on its application to the determination of the water equivalent of calorimetric bombs. CHARLES MOUREU, CHARLES DUFRAISSE AND PHILIPPE LANDRIEU. *Compt. rend.*, **177**, 996–7(1923).—The authors have learned that their supposed new methods of using twin calorimeters (*C. A.*, **18**, 933) was described by

PFAUDLER, and propose to call it by his name. [It was really originated by JOULE (1845), however.—ABSTR.] W. P. W. (*C. A.*)

The relation between Young's modulus and atomic volume. ALBERT PORTEVIN. *Compt. rend.*, **177,** 634–6(1923).—PECZALSKI's formula connecting YOUNG's modulus E with density and at. mass $E = 8 \times 10^5(\delta/M)^2$ in kg./sq. mm. has been applied to definite chem. compds. The calcd. values when compared with those obtained by direct measurement or deduced from the compressibility values show about the same degree of error. By means of the formula one can obtain an indication of the order of magnitude of the modulus. L. T. F. (*C. A.*)

Oxidation of chromite and preparation of chromates. BOGITCH. *Compt. rend.*, **178,** 2254–6(1924).—B. gives results of expts. upon conditions of roasting which give most complete oxidation. Chromite from New Caledonia, contg. 52% Cr_2O_3 and 12% FeO and Fe_2O_3, ground to 200 mesh, was heated in small boats in a tube furnace. The proportion of fluxes required varies with the ore and also with conditions of roasting. For the sample used more than 60 parts of CaO and more than 25 parts of Na_2CO_3 per 100 parts of ore were required to obtain 90% oxidation. By using 100 parts CaO and 70 parts Na_2CO_3 per 100 parts ore and heating 1 hr., 900° was found to be the optimum temp. producing 97% oxidation. At this temp. with layers 2–3 mm. thick oxidation was 80% complete in 15 min., 92% in 30 min., 97% in 60 min. and 97.5% in 120 min. By heating 1 hr. at 900° and using for 100 parts of mineral 70 parts of alkali salt and 100 parts of CaO or $CaCO_3$, the following per cents of the Cr_2O_3 were oxidized: Na_2CO_3 + $CaCO_3$, 99%; Na_2CO_3 + CaO, 97%; CaO + NaCl, 58%; CaO + Na_2SO_4, 70%. A. R. M. (*C. A.*)

Viscometry and plastometry. A. DEWAELE. *J. Oil Colour Chem. Assoc.*, **6,** 33–88(1923).—A discussion of viscous flow, kinetic energy correction, slippage, turbulence, end effects, etc., as applied to viscosity measurements with capillaries. The plastometer used embodies the usual principles of efflux viscometers excepting that higher pressures of shear than can conveniently be obtained by a head of liquid are obtained by air pressure. The app. is described in detail, and results are plotted and tabulated. These indicate that the work of BINGHAM, GREEN and others (*C. A.*, **14,** 1047; **16,** 2447) has been based on an insecure foundation in that curvature of the relationship between pressure and vol. of flow per unit time has been interpreted as slippage; this resulted from their failure to explore the P/Q relationship at sufficiently high rates of shear and from confining their attention to substances of low plasticity. A direct mathematical disproof is derived of the validity of the relationship expressing BINGHAM'S law of plastic flow. The analogy between plastic bodies and liquids is shown by simple relationships of the equations of shear. Discussion and correspondence follows. BINGHAM and GREEN wholly disagree with deW.'s conclusions and formula. F. A. W. (*C. A.*)

Heat balance for gas producers. W. B. CHAPMAN. *Chem. Met. Eng.*, **29,** 270–1 (1923); *Iron Coal Trades Rev.*, **107,** 294; cf. *C. A.*, **17,** 3088.—The av. of 12 typical tests on the HUGHES, MORGAN, WOOD and CHAPMAN producers is taken as the basis. The heating value of the gas was 154 B.t.u. The input shows 97.5% in the coal and 2.5% in the steam. The efficiency of the producer, cold gas 74.61%, hot gas 86.03%; total losses 13.97%—radiation 11.69%, sensible heat of cooling water 0.97%, unburned C in soot 0.97%, in ash 0.34%. Specific directions are given for calcg. the different items in the heat balance. J. L. W. (*C. A.*)

The indentation hardness of metals. K. HONDA AND K. TAKAHASHI. *J. Iron and Steel Inst.* (advance proof), **1924,** 11 pp.—In the usual method of measuring the Brinell hardness, the impression is measured after the load is removed; but in hard metals, and especially in quenched steels, the recovery of the impression after unloading

is considerable, so that the hardness thus obtained is very ambiguous. The Brinell hardness, when the impression is measured during the application of the load, is quite correct, and much less than that by the usual method of measurement. As the definition of hardness, the present authors adopt that proposed by WÜST and BARDENHEUER; that is, the hardness is measured by the work required to produce the unit vol. of impression. The hardness depends upon two consts., k and a, characteristic of the substance; k depends on the elastic deformation, and a is the const. depending on the permanent deformation beyond the elastic limit. In the new definition of hardness, the initial hardness is given by $H_0 = k/\pi D$, D being the diam. of the ball. The hardness for a given load is $H = k(3 + 2ah)/\pi(3D - 2h)$. This obviously increases with the load. E. A. M. (*C. A.*)

The determination of minerals by the microscopic examination of their streaks. P. GAUBERT. *Compt. rend.*, **177**, 960–2(1923).—The general procedure is discussed. The streak upon a depolished plate of glass or quartz permits a more rapid detn. than the examn. of powder and has a further advantage of using but traces of the mineral. This method is delicate, *e. g.*, 0.00001 mg. of galena with HNO_3 will show crystals of $Pb(NO_3)_2$. L. W. R. (*C. A.*)

Sintering: its nature and cause. R. C. SMITH. *J. Chem. Soc.*, **123**, 2088–94 (1923).—It has been shown that: (1) sintering may take place in cryst. and amorphous substances; (2) the sintering of a cryst. substance is due to a change in size of the crystals or to the formation of an allotrope; (3) the sintering of an amorphous substance is due to the formation and growth of crystals. H. J. C. (*C. A.*)

Reduction of copper oxide by carbon monoxide and the catalytic oxidation of carbon monoxide in the presence of copper and copper oxide. H. A. JONES AND H. S. TAYLOR. *J. Phys. Chem.*, **27**, 623–51(1923).—The reaction $CuO + CO = Cu + CO_2$ occurs at a Cu-CuO interface, the production of CO_2 being negligible until Cu nuclei are established in the mass of CuO. As the boundary between the solids extends outward from the nuclei, the rate of CO_2 production increases at first and then diminishes as the reduction of CuO is completed. The original formation of Cu nuclei is retarded by the presence of CO_2. A suggested explanation is an adsorbed protection film of CO_2 on the CuO surface. This process is also retarded at low temp. by O in small concn., which oxidizes any Cu produced and thereby retards the spread of the Cu-CuO interface. At high temps. the formation of the nuclei exceeds the oxidation rate so that the reduction increases with time. The reaction $2CO + O_2 = 2CO_2$ in the presence of CuO is relatively slow with alternate reduction and oxidation at the interface. In the presence of reduced Cu the reaction is practically instantaneous and consists of the oxidation of an adsorbed layer of CO. These results are strikingly parallel to those of TAYLOR and BURNS (*C. A.*, **15**, 3922) on the combination of H and O over Ni. The "poisoning" by O in the CO-O_2 combination over Cu is classed as permanent because reduction of CuO is necessary rather than the sweeping out of an adsorbed substance. J. M. B. (*C. A.*)

Action of silica on electrolytes. A. F. JOSEPH AND J. S. HANCOCK. *J. Chem. Soc.* **123**, 2022–5(1923).—The effect of SiO_2 on a soln. of an electrolyte appears to be due to a chem. change resulting in the formation of free acid and of a complex silicate of low soly. but alk. reaction. Pure SiO_2 produces no effect on a soln. of an acid. The reduction of acidity ordinarily observed does not occur when the SiO_2 is well purified. H. J. C. (*C. A.*)

Constitution and evolution of precipitates of alumina. P. PASCAL. *Compt. rend.* **178**, 481–3(1924); cf. *C. A.*, **17**, 672, 697.—The magnetic susceptibilities of the following prepns. were measured: 1*a*, gel formed by addn. of excess of NH_4OH to a satd. soln. of alum; 1*b*, the same left 50 hrs. in contact with the liquid; 2, gel obtained by drop-

wise addn. of the theoretical amt. of NH_4OH to satd. alum soln.; 3, gel prepd. like the preceding but with merely moistened alum which was continuously ground in a mortar during the addn. of NH_4OH; 4, cryst. Al_2O_3 from solns. of K aluminate; 5, anhydr. Al_2O_3 derived from the preceding prepns. *Conclusions.* At formation the gels consist solely of anhyd. Al_2O_3 with adsorbed water; on long standing this Al_2O_3 hydrates to the unstable $Al_2O_3.3H_2O$ of VAN BEMMELEN, which is quite distinct from the cryst. hydrate (4) of the same compn.; neither form is to be regarded as $Al(OH)_3$ and this distinction makes comprehensible the insoly. of these gels in the alk. liquids in which they are pptd. In solns. of aluminate practically all the Al is present as colloidal Al_2O_3; in them $Al(OH)_3$ is not detectable by magnetic analysis. This substance, like orthostannic and orthosilicic acids, has not been isolated. A. R. M. (*C. A.*)

Determination of carbon in fuels, organic matter, refractories, alloys, etc. E. GOUTAL. *Chaleur et industrie,* **5,** 409–12(1924).—The method consists essentially in burning on O under pressure of about 20 atm. in a two-valve bomb, passing the combustion gases through standard NaOH, pptg. CO_2 with $BaCl_2$, and titrating the excess of NaOH. The valves are on the body of the bomb and permanently connected to the O cylinder and the absorber, resp. The cover carries only the elec. connections for ignition. With difficultly combustible material, combustion is ensured by use of about 4 g. of Fe filings. The app. and technic are minutely described. The method is quick and accurate, and gives the same results as the usual combustion in a furnace with O atm. pressure. But with exceptionally difficultly combustible materials (*e. g.*, alloy steels), the bomb gives slightly higher results owing to more complete combustion. A. P.-C. (*C. A.*)

PATENT

Process of making sodium aluminate and other products. CHARLES E. PARSONS. U. S. 1,522,698, Jan. 13, 1925. The process of making sodium aluminate, calcium silicate and magnesium silicate from blast fur. slag contg. combined aluminum, calcium and magnesium, which consists in finely dividing said slag; adding sodium hydroxide thereto, digesting the mixt. thus produced at a superatmospheric press. until the desired products are formed; sepg. out the sol. sodium aluminate from the insol. silicates thus produced; and sepg. out from the residue the desired calcium and magnesium silicates.

General

Utilization of waste gypsum. KIYONOBU KISHIMOTO. The Osaka Indus. Lab., *Bull.* **5** [2], 12(1924).—Plaster of Paris prepd. from waste molds or other artificial gypsum is usually useless, since plaster or molds made of it are weak and porous. However, the waste gypsum can be used in the manuf. of Keenes or Marble cement. The author has studied the manuf. of Keenes cement from waste molds and has succeeded in prepg. the cement, which is equal in quality with that made of natural gypsum, with the following process: The waste gypsum is dehydrated to sol. anhydrite at 150–170°C, dipped in 3–5% soln. of alum overnight so as to make the content of anhydrous alum in the finished product lie between 1.5–2.5%, and is then ignited at 700–800°C for an hour. The ignition at a too low temp. makes the product grey and not friable, while that at too high temps. reduces its strength; its setting is accelerated with increase of alum. Other processes, *e. g.*, one, in which the waste molds were heated at 700°C instead of 150–170°C as described above, gave poor results. S. K.

Refractory industry of New Jersey. F. B. ALLEN. *The Ceramist,* **5,** 21–8(1924).—Besides a brief history of the industry, the author describes the processes used in manuf. He attributes the disparity of the growth of the industry in N. J. as compared with that in Pa. and Ohio to the following causes, namely, the development of the iron and

steel industry in western Pa., higher cost of the soft mud process commonly used in mfg. N. J. fire brick; the lack of cheap fuel; and the higher cost of mining N. J. clays. C. W. P.

Winning and preparation of English china clay. GEO. BRIAN. *The Ceramist*, **4**, 271–82(1924).—Brief historical statement together with detailed description of processes used. C. W. P.

Liquid air as an explosive for blasting large masses. A. J. M. *Rev. Mat. Constr. Trav. Pub.*, **182**, 292–6(1924).—On a surface cutting 52 m. long, 6–9 m. wide and 12 m. high, 10 holes were drilled about $11\frac{1}{2}$ m. deep and $4\frac{1}{2}$ m. apart. Each hole was charged with 12 cartridges of liquid air, each 50 cms. long and 12 cms. in diameter. A total of 800 l. of liquid air were necessary. The ignition was effected with detonating cordon, the 10 explosions occurring simultaneously. About 4000 cu. m. or 8000 tons of limestone were displaced. For the work the cost of the explosive is estimated at half that for ammonal, and at a third for dynamite. Another expt. wherein 4 holes were charged at the same time is also described. Plans of the borings with photographs of the setting before and after the explosions are included. L. N.

Sand blast sand. W. M. WEIGEL. Repts. of Investigation, No. **2615**(1924).—Bur. Mines Serial. P. D. H.

Show your business in pictures. G. W. GREENWOOD. *Brick and Clay Rec.*, **65** [12], 834–9(1924).—A new and simple idea in charts is given which enables the manager to tell at a glance the status of his plant. Charts showing sales, production, shipments, accounts receivable and other such data have been prepd. from a representative table, and are included. P. D. H.

Lubrication of clay working machinery. ANON. *The Clay-Worker*, **82** [5], 388 (1924).—The September, 1924, number of the house organ publication called "Lubrication," issued by the Texas Company, 17 Battery Place, N. Y. City, was devoted to the subject of lubrication of clay products machinery. The type of lubrication is given that is best suited, including everything from hoisting equipment to drier cars. Pottery machinery is also included. P. D. H.

The production and marketing of clay. ANON. *The Clay-Worker*, **82** [5], 393 (1924).—The special report of the U. S. Geological Survey on the clay mined and marketed in the U. S. in 1923 is briefly reviewed. This report prepared by JEFFERSON MIDDLETON has been issued as a section of the report on the Mineral Resources of the U. S., 1923, part II, pages 71–78. P. D. H.

The proper lubrication for gears. A. L. NUGEY. *The Clay-Worker*, **82** [5], 402 (1924).—The lubricant should be of a very viscous nature. A very viscous oil offers the greatest resist. to being squeezed out between the pressure surfaces of gear teeth. To produce such a fluid lubricant requires a mixt. of a pure mineral oil with castor oil which must be effectively combined in order to insure against subsequent separation. P. D. H.

Clay output in U. S. (1923). ANON. *Jour. Soc. Chem. Ind.*, **43**, 1260(1924).—The clay mined in 1923 was 3,434,660 T. as compared with 2,647,700 T. in 1922. Imports of clay increased by 30,703 T., or 9% in quantity, and $266,348, or 8% in value. Clay exports increased by 37,219 tons or 78% and the value increased $195,295, or 45%, compared with 1922. H. H. S.

Elementary science in relation to clayworking. VI. ANON. *Brit. Clayworker*, **33**, 225–6(1924).—The determination of lime in clays is described. H. G. S.

The best type of drive. ANON. *Brit. Clayworker*, **33**, 229–30(1924). H. G. S.

The service rendered by technical societies. A. T. HINCKLEY. *Trans. Am. Electrochem. Soc.*, **45** (preprint)(1924).—Presidential address. C. G. F. (*C. A.*)

Research work in industry. J. G. PEARCE. *Iron Coal Trades Rev.*, **109**, 202

(1924).—British industry remains in the hands of independent manufg. concerns, limited in size and output. This condition makes for the development of research on a coöperative basis, as the Cast Iron Research Association. This organization maintains a technical information bureau and does research on special problems described.

J. F. B. (*C. A.*)

Selective instruction. ALEXANDER SILVERMAN. *Ind. Eng. Chem.*, **16,** 858–9 (1924). E. J. C. (*C. A.*)

The calculation of heat regenerators. EDMOND NOAILLON. *Rev. universelle mines*, **17,** 413–48(1923).—Purely mathematical. Formulas are developed for detg. the *temps. of gases leaving regenerators* and *the heat recovered*, from which the best dimensions and construction of regenerators can be calcd. The derivation is very complex, since the final temp. and heat recovered depend on the heating surface and its temp. at all points, the latter in turn being a function of several variables. C. C. D. (*C. A.*)

Molding sands and mold tests. L. TREUHEIT. *Stahl u. Eisen*, **43,** 1494–8(1923).—The ordinary method of testing cores or molds is by pressure of the fingers. A gage here is recommended which will give more uniform readings and thereby tell more exactly the condition of the mold. When molds are stamped by hand, machine or air hammers, the uniformity is hard to gage. Since the casting is affected by the condition of the mold, the gage here described is used to test this condition.

W. A. M. (*C. A.*)

PATENT

Artificial meerschaum. P. DEUSSING. U. S. 1,507,545, Sept. 2. A substance commonly used for the manuf. of earthenware composed of Hallic earth and Meissner clay is ground with whiting and quartz dust, H_2O is added and the mixt. is subjected to filtration to form a paste. The latter is allowed to dry after placement in well dried molds and is then subjected to biscuit baking as in the manuf. of porcelain. (*C. A.*)

Personnel of Local Sections

	Baltimore Washington	California	Chicago	Detroit	New England	Northern Ohio	Pacific Northwest	Pittsburgh	St. Louis
Chairman	Herbert Insley	T. S. Curtis	W. J. Benner	A. B. Peck	A. E. Baggs	A. S. Zopfi	Hewitt Wilson	J. W. Cruikshank	F. E. Bausch
Vice-chairman	A. N. Finn F. G. Roberts	Robert Linton A. L. Gladding				E. P. Poste	H. Hoffmann	J. Spotts McDowell	
Secretary	R. R. Fussel-baugh	H. E. Davis	B. F. Wagner	H. F. Royal	C. H. Lawson	Geo. H. Hays	S. Geijsbeek	H. F. Robertson	L. C. Hewitt
Treasurer		H. A. Huisken	B. F. Wagner	H. F. Royal	C. H. Lawson	Geo. H. Hays	H. B. McMillan	T. H. Sant	L. C. Hewitt
Councillors	B. T. Sweely	F. B. Ortman	C. W. Parmelee	F. H. Riddle	A. A. Klein	R. D. Landrum	Samuel Geijsbeek	F. W. Walker	A. F. Daves
Membership	H. Turk A. N. Finn	John Sawyer	L. H. Menne	R. Twells		R. A. Weaver F. P. Nickerson L. W. Manion	J. B. Stirratt J. G. Anderson T. S. Mann		Geo. E. Thomas, *Chairman* H. C. Arnold P. C. Ray Arnold Herold
Program	R. F. Geller, *Chairman* R. R. Fussel-baugh	H. E. Davis	A. F. Gorton	M. D. Lucas W. A. Carter H. M. Kraner		L. D. Mercer G. T. Stowe P. Dressler	F. T. Houlahan H. R. Kreitzer P. S. Mac Michael	J. S. McDowell F. C. Flint *Entertainment* H. G. Willetts	C. W. Berry, *Chairman* C. H. Modes F. G. Saeger
Executive	H. Insley F. G. Roberts R. R. Fussel-baugh	*Constitution and By-Laws* T. S. Curtis			M. F. Cunningham	A. S. Walden W. M. Clark	V. E. Piollet A. L. Bennett G. MacFarlane		F. E. Bausch L. C. Hewitt A. F. Daves G. E. Thomas C. W. Berry
Nominations	D. E. Parsons Karl Turk			H. F. Royal	A. A. Klein M. F. Beecher		W. E. Lemley E. F. Goodner J. O. Hankins	A. W. Kimes R. F. Ferguson J. W. Cruikshank	J. L. Crawford

Plant No. 1

EUREKA
FLINT & SPAR Co.

THE name "EUREKA" is synonymous with Feldspar. For the past twenty years, we have been the leaders in the Feldspar Industry.

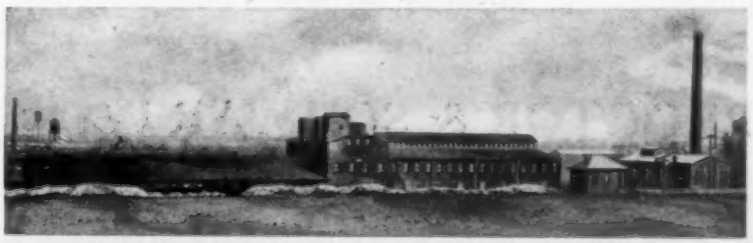
Known for its superior quality and uniformity, EUREKA Feldspar is recognized as the best, and is used exclusively, by the largest manufacturers of Ceramics in America.

We also carry a large stock of genuine English Cornwall Stone, French Flint and American Crystal Rock Flint, thus are able to meet your requirements immediately.

Eureka specially selected Glaze Spar is famous for its brilliant luster.

EUREKA FLINT & SPAR CO.
Trenton, N. J.

Plant No. 2



"Proctor"

DRYING MACHINERY

for all Clay Products

Electrical Porcelain
Sanitary Ware
General Ware in Moulds
Dipped General Ware
Clay Rolls :: Spark Plugs
Saggers :: Tile
Refractories :: Brick
Chemical Stoneware

PROCTOR & SCHWARTZ, INC.
PHILADELPHIA, PA.

(When writing to advertisers, please mention the JOURNAL)

BULLETIN

of the

American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Mary G. Sheerer, Chester Baldwin, M. E. Manson, H. G. Wolfram	Art, Enamel	A. Silverman, A. N. Finn	Glass	E. C. Hill, G. W. Tucker	Terra Cotta
		C. E. Bales, L. C. Hewitt	Refractories	J. D. Martin, A. P. Potts	Heavy Clay Products
		F. H. Riddle, F. H. Rhead	White Wares		

OFFICERS OF THE SOCIETY

E. Ward Tillotson, President
Mellon Institute, Pittsburgh, Pa.
F. H. Rhead, Vice-President
American Encaustic Tiling Co., Zanesville, Ohio
H. B. Henderson, Treasurer
Standard Pyrometric Cone Co.
1538 N. High St., Columbus, Ohio
Ross C. Purdy, General Secretary
Helen Rowland Fox, Assistant Secretary
Emily C. Van Schoick, Assistant Editor
Lord Hall, O. S. U., Columbus Ohio

TRUSTEES

R. D. Landrum
A. F. Greaves-Walker
R. R. Danielson
J. C. Hostetter
C. Forrest Tefft
J. S. McDowell
R. L. Clare
C. C. Treischel
Paul E. Cox

Vol. 4 **March, 1925** **No. 3**

EDITORIALS

THE BEGINNINGS OF CERAMIC EDUCATION IN THE UNITED STATES[1]

By Edward Orton, Jr.

The sense in which the phrase, "The beginnings of ceramic education" is used, is open to two interpretations. The simple and obvious meaning, of course, deals with the formal establishment of a school and the beginning of class work. But I venture to say that never did any educational movement actually have its beginnings on the opening day of a school. A school, if it ministers to a real need of mankind, is sure to have its roots deep down in years of groping and more or less inarticulate quest on the part of great numbers of people. And, by that same token, the real beginnings of education in any subject are found when some student and thinker produces and gives to his kind a scholarly achievement in that subject, be it a history, discovery, or prophesy, anything which clarifies hazy thought—which crystallizes views and opinions—which enables the mind to visualize what it could not previously isolate from other partly known or partly guessed facts.

I take it that on this occasion, it is to this second or broad aspect of the

[1] Address on the Thirtieth Anniversary of Ceramic Education, held at the Ohio State University, Monday, February 16, 1925.

subject that we should devote ourselves, especially as what need be said upon the first can be well covered in but little space.

In the sense, then, that education means scholarship rather than schooling, ceramic education in the United States had its rise chiefly in two contributing streams, which flowing more or less parallel for a time finally came together with the establishment of the first ceramic school. These two streams were first, the work of mining engineers and metallurgists, to whom silicate chemistry chiefly meant the art of controlling the formation of fluid slags in their furnaces, to the end that they might separate the metal from its ore, and secondly, the work of the economic geologists, who felt that their mission in life was to tell what our mineral resources were, and for what they might conceivably be used.

It would not be fair to wholly exclude from a share of this early scholarship, the representatives of the ceramic industries themselves, or to deny that the cravings for better knowledge on the part of clay workers did add its quota to the growing science. But to follow the analogy used earlier, their early contributions to the technology of ceramics in this country were as a small rivulet compared to the two main streams above set forth.

The work of the mining engineers and metallurgists, for they were both the same thing in those days, necessarily concerned itself as before stated with slag production. They were the first to teach in the technical schools of this country the art of practical control of silicate melts. In their search for rational practical rules for varying the fusibility of silicate melts, they devised and used the oxygen ratios of the basic and acid constituents of the slag. They borrowed from mineralogy the crude molecular formulas by which mineral compositions were then indicated or guessed at. In the variety of bases existing in and apparently entering into perfect combination in the commonest silicate minerals, and in the fluctuating ratios in which they seemed able to take part in the formation of an apparently definite crystalline compound, they found the warrant for using fractional molecular formulas for expressing the constitution of these slags. And they found these ratios, however unscientific the conception of fractional molecules might be, the only practical or fruitful way to get at the question of silicate formation and control, so vital to their business.

Another thing which the metallurgist taught us was that the physical characteristics of a melt might be predicted on the basis of this same fractional molecular formula or oxygen ratio. He produced slags ranging from fairly perfect transparent glasses, all the way down through the vitreous, the vitrified, the stony, to the crumbling self-slaking material which set into an hydraulic cement on exposure to weather. Thus his work tied into that of the glassmaker on the one end, then the clayworker, and finally on the other extreme the cement manufacturer, and showed all through their kinship and the key to their common problems.

In still another way, the metallurgist touched upon the field of the future ceramist, *viz.*, in his study and use of refractory materials. To the metallurgist, these are the key to his business, the *sine qua non* of successful operation. The metallurgist seldom if ever devoted to the study of clays or other refractories any very extended attention, other than to settle the apparent cause of failures and unsatisfactory results in his furnace walls and hearths. In other words, his studies were more or less impatiently diverted from what he considered his real field—the metals, their ores and their reduction, to the clays, the quartz or the basic minerals used to hold his molten fluids in their crucibles. But, whether he studied clays because he liked to, or because he had to, matters not, for he very successfully established the fundamental principles of the art of making refractory materials, and choosing the appropriate refractory for a given purpose.

In these three several ways then, the metallurgist had laid the foundations for the ceramist before the latter began to claim his field, the use of fractional molecular formulas to express the ratios of silicate compositions, the association of physical properties with molecular ratios in silicate melts, and the use and theory of making heat resisting minerals for furnaces.

The great avenue through which these researches were made available to engineers, chemists and metallurgists was through the Transactions of the American Institute of Mining Engineers. This great society was for years a powerful figure in metallurgy and chemistry as well as in mining and ore-dressing. There were also some high grade technical journals which published some original matter, such as the *Engineering and Mining Journal* of New York and others. But, in general, these papers reworked the Proceedings of the A. I. M. E. and other scientific and technical bodies, and made them more generally available.

But, while credit must not be withheld to these early metallurgists, mineralogists and chemists, who let in the first light on the foundations of ceramics, it must also be said that they had no special interest in ceramics, were not working in ceramics, and so far as they were concerned, there would probably have been no such thing as ceramic engineering recognized today, if the matter had been left to them. Their contributions to this field were incidental, because in both metallurgy and ceramics, silicate production was an essential element—in the one as a by-product, and in the other as the principal end in view.

The other principal source of help to the clayworker in pre-ceramic school days was the work of the geological surveys of the several states. The economic geologist was perhaps less directly a contributor to the chemical foundations, to ceramic chemistry, if one may use that phrase without offense to our chemical friends who say that chemistry is chemistry and needs no qualifying adjectives, than the metallurgist. He helped,

sometimes, on the mineralogical end, and he forced the clayworker and later the ceramist to broaden his foundations, and to get some conception of the complex mineral mixtures which constitute our clays. Without the work of the geologist, in explaining how rocks are made, and unmade, and the complex combinations, solutions, blendings, washings, elutriations, sedimentations, weatherings and denudations through which the surface materials of the globe are constantly passing, the ceramic chemist would have made slow work in getting a conception of what a clay is, and why it is as it is, and what one may expect of it and what not.

But as in the case of the metallurgist, the interest of the geologist was incidental rather than direct. Clay was to him, and I may say, still is, among the least interesting of all rocks, because of its indefiniteness of composition and character. There is so much of it, that perforce he must treat of it in accounting for his mineral menu, but he has left it to the last, usually, in describing the mineral assets of any region. In the publications of the early geological surveys of the different states, no important treatises on clays or clay resources appeared until pretty much everything more spectacular had been written up.

But gold and silver are not everywhere. Iron, copper, lead and zinc, too, cannot always be depended upon to fill reports. So, in the end, the economic geology volumes got down to the homely rocks and minerals—the sandstones, the limestones and lastly the claystones. And we owe these old surveys a great debt, for they did bring together enough of the mineralogy and geology of clays to make the chemical problems of the clayworker much more intelligible, and his efforts to control composition and properties of ceramic mixtures much more certain than would have been otherwise possible.

But, curiously enough, the early geological surveys made another contribution to ceramic engineering, scarcely less important or fundamental than what they told as of the origin, composition, properties and occurrence of clays. They gave to the world, if not the first, at least the best treatises on the technology of the clay industries. The older books written by clay workers upon the processes of their art are rather heavy and lumbering material, compared to the much better treatises which appeared in the geological reports of various states.

The pioneer of these reports was Cook's Report on the New Jersey Clays published about 1874—which was followed by that of Ohio in 1883 and again in 1893, and that of Wheeler in Missouri in 1897. Many others have followed, but mostly after ceramics had set its seal on this field and usually the later works were done by men of more or less ceramic training. But it is a fact that the first and for a long time practically the only effort to discuss kilns, driers, mechanical processes for forming ware, plant layout and design occurred in the geological survey reports,

and from there they filtered slowly into the trade through direct use of the books and the reworked articles in the trade journals.

It may well be enquired what contributions to ceramic technology, coming directly from the industry, had appeared in English texts as a source of inspiration to the clayworker and ceramist prior to the advent of the schools. There was a very marked paucity of such material. In 1894 an effort was made to obtain everything directly bearing on the science of ceramics in any language for the library of the newly established school. There were in all about 60 or 70 books found, 75% were in German, 15% in French and the remaining 10% were in English, but nearly all discussed English ceramic practice, which differs so markedly from American practice as to afford practically no assistance to our clayworkers here.

In 1895 a little volume appeared, printed in a small edition which was soon exhausted, which marked the turning point in this country. I refer to the "Chemistry of Pottery" by Karl Langenbeck, then chemist of the American Encaustic Tiling Company of Zanesville. This book made at once a profound impression, it was like opening a blind and admitting a brilliant beam of sunshine into a large dark hall. Though it did not illuminate the corners, it gave that first priceless illumination which showed the outlines of the space, and where the corners were. Nothing that has appeared before or since originally in English, has exercised so great an effect. The translation of Seger's "Collected Writings" in 1900 was an epoch-making step to Americans, placing the wealth of Seger's knowledge and his still more valuable methods of approach to ceramic problems in their reach. But that was a foreign book, and came after Langenbeck's by several years.

At this same time, the trade journals in the English language dealing with clayworking were few and not of high grade. No English speaking journal in the early days up to about 1895 or possibly 1900 appeared which compared at all favorably with several of the German technical journals, which were the place of original publication of much of the very best work done by the brilliant and able German, Hermann A. Seger, his pupils and successors. The English and American trade journals were very slow in getting upon a scientific plane and while they helped to circulate what matter did appear in English upon ceramic subjects, it can not truthfully be claimed that they produced much new material, or really added much to human knowledge in this field.

The literature of ceramic art prior to 1900 was abundant, in many languages. Even English had many large and costly treatises, dealing with history, the marks of various potters, illustrations of their wares, and a wealth of material upon the design and embellishment of pottery, tiles, glass and enameled wares of all ages. But this material, of course has

little value to a scientist or engineer, for when the artist, or collector, or connoisseur writes of his specialty, it almost invariably shows the paucity of his knowledge of the chemistry and technology of the subject.

In the foregoing, I have tried to indicate what the situation of the American clayworker and ceramist was, so far as sources of technical information on his business were concerned, in 1894. He had virtually no treatises, and those accessible described an industry wholly different from the clayworking he knew about in practice. He had no journals, excepting those which knew no more than he knew himself. Those which he had did not bring to him the stores of knowledge tied up in scientific literature in foreign tongues and general chemical publications. He had no technical societies of solid scientific or engineering grade. The one clayworking organization of more than local extent in those days was the National Brick Manufacturers' Association—then about six years old, and keenly alive, anxious and ready to use anything that had apparent scientific or engineering merit. But its management was non-technical, and unable to give it scientific guidance, and while the clayworkers of the country owe it much, it has never become an association of professional grade. The clayworker and ceramist did have access to a limited but very valuable literature in metallurgy and geology, if he had the training to understand them, and the ability to apply their lessons to his own problems, which were not the same, though parallel.

It may not be improper to briefly trace the influences and forces which led up finally to the establishment of the first English speaking technical school of engineering grade for clayworkers at this University in 1894.

As usual in all human undertakings, a real step in advance comes from the effort to meet a bitter personal need. It is so with every invention and every discovery, or almost every one. People do not often hunt for things which need doing and deliberately set themselves to do them as a matter of general interest. At least, the day of the research student in pure science had not made itself so evident 30 years ago as it is now. And even the research man, though he may not know to what use, if any, his facts will be put when discovered, is usually working systematically to fill a gap in knowledge with very definite intent.

The personal need which furnished the motive for the effort which resulted in the founding of the first ceramic school was brought out into the open by the effort of an individual trained as a mining engineer, that is to say with some metallurgical, chemical and geological knowledge and experience—to solve the problems of an ordinary clayworking industry. With such an education, and seven years of mining and metallurgical experience behind him, he attempted to operate a paving brick factory, with that sublime confidence which seems to protect the young and inexperienced from the worst consequences of their folly.

It is not necessary here to relate his trials and his failures. Suffice it to say that after two years of top-notch effort, he found that while his experiences did not disprove his chemical and metallurgical conceptions, or make him lose confidence in their basic soundness, they did show him conclusively that his training gave him only a very superficial grasp upon the problems of this ancient industry of clayworking.

Then, by chance, the opportunity came to him to visit in an official capacity, hundreds of ceramic works in Ohio and neighboring states, and to exchange views with their respective leaders, and to endeavor to interpret their troubles and problems. And, out of these conferences, came the realization that here was a mineral industry, one of the greatest, ranking second only to iron and steel in value of output, the oldest probably of all the arts of man, floundering along in the dark, without help, or interpretation, or preparation. And this realization accomplished what the personal need would probably not have accomplished—it would have been easier to change back to metallurgy or mining again. It brought the determination, in behalf of the thousands of men struggling along in the dark, to provide a means whereby the principles of chemistry and physics and geology and metallurgy could be applied specifically to the field of the ceramist, and whereby young men might be trained to draw their illustrations and make their analogies and work out their theories in terms of clays, and glazes, and enamels, instead of with metals and slags. It is the same chemistry and physics and mathematics, no matter to what it is applied, but the human mind is not often so keen that its logic can cleave mercilessly through all the entanglements of the unfamiliar, and at once strip the problem down to its bare bones. Once in a generation does such a thinker appear. But most men's vision does not go materially beyond the field of their experience, and the training of chemists to work in clays is just as logical and just as necessary to progress as to train them to work in metals, or in dyes or in physiological serums.

So, out of the combination of personal need and a realization of the widespread need of others, the determination to start this school took form. It was a rash, almost a fool-hardy venture. It could never have taken place in any other country but our blessed America. But here, thank heaven, anybody can usually get the chance to make a fool of himself in his own way, at least once—and sometimes his folly leads to success.

The actual steps of the founding of the first clayworkers' school—the working up of the project—the solicitation of support of the clayworkers—the enlisting of the aid of organizations—the passage of an enabling act by the legislature—the final passage of the appropriation and the beginning of the work, do not offer anything of special novelty or outstanding interest, and the story has been told several times before. But, of all of that loyal group of people, many of them far from sure that the proposal was possible

of success, or of much value if successful, who worked so hard to put the proposition over, and who rejoiced so heartily when it was at least assured, there can hardly be one today who is not deeply grateful that he was so fortunate as to have had a hand in the beginnings of an enterprise, whose effects have been so far reaching and whose influence has been so mighty.

THIRTY YEARS PROGRESS IN CERAMIC EDUCATION[1]

By A. V. Bleininger

Ceramic education during its early period was undoubtedly built upon the work of H. A. Seger, and too much credit cannot be given to the clear and logical premises which he established. Seger's work was of the quality which endures, and much of what he said holds today as it did forty years ago. His was the true scientific spirit, searching humbly for the truth.

Building upon the foundation erected by Seger but broadening the scope of research, our Professor Orton erected the superstructure of American ceramic technology which he at once widened into a conception which included all silicates used or produced in the industrial arts.

The mode of attack employed by the Orton school of ceramic technology was that of a refined empiricism built upon the chemical and physical conceptions current at that time. There was a strong leaning toward the use of the methods of metallurgy as exemplified by the contributions of the American Institute of Mining Engineers, which at that time was in the full flower of its virile existence. This was but natural since Professor Orton was by profession a metallurgical engineer.

The difficulties involved in the precise study of the clay silicates then, as now, were great. Even the chemical analysis of the silicates is a slow and laborious operation and to obtain an insight into the real structure of the raw or fired materials it was necessary to resort to the employment of indirect methods and the measurement of such phenomena as loss in weight and contraction in volume. Clays are such poorly defined, opaque arrangements of mineral matter that even under the modern methods of microscopic examination they only yield partially to the experienced petrographer. At that time the conceptions of colloidal chemistry were entirely absent.

The situation was somewhat different as regards glass which, owing to its physically more homogeneous character, and its transparency, was capable of being studied with greater facility. We find thus as early as 1881 that systematic investigation of glass was begun at Jena which yielded

[1] Address on the Thirtieth Anniversary of Ceramic Education, Ohio State University, Feb. 16, 1925.

that remarkable series of studies by Abbé and Schott which have become classic, and which still offer a fine example of how the physical properties of a substance may be correlated with its chemical composition.

Again, in the case of the hydraulic silicates, particularly Portland cement, their crystalline character offers a means of direct attack through petrographic study. In this field that master investigator, H. Le Chatelier, gave us the first insight into the nature of Portland cement in 1887.

Since all the igneous reactions of the silicates involve as determining factors both temperature and time, it is obvious that one of the main requisites for study in this field was the accurate measurement of the more elevated temperatures. This was afforded by the introduction of the thermoelement and the high resistance millivoltmeter. One of the first instruments installed by Professor Orton was a pyrometer of this type. It is questionable whether Orton could have conducted his classical work on the oxidation of carbon in clays without the aid of these more precise means of measuring high temperatures. At least it could not have been done so well. This topic cannot be dismissed without some reference to the early work of the newly created Bureau of Standards on pyrometry which was of great importance in assisting in this development.

Gradually, then, our more or less empirical studies yielded to conceptions introduced through the development of the fundamental sciences. But it must be realized that in meeting the demand of the industries for specific information it was difficult to avoid the use of the methods which had produced useful results more rapidly than the precise but time consuming measurements of the physical and chemical laboratory. Pioneering work cannot always be choice in the means of its progress.

At the same time we were confronted with the necessity of assimilating and correlating the vast experience of practical industry. For decades there had accumulated a large stock of practical information, and it became imperative that this be studied and classified. Without an acquaintance with this reservoir of knowledge any contemplated work would often be a duplication or misdirection of effort. This aspect of ceramic investigation must not be neglected, and it explains why very often laboratory studies are carried on which have been solved in practice many years ago.

Physical chemistry finds itself at a disadvantage when dealing with silicate reactions which take place at furnace temperatures, and which are limited by physical heterogeneity, enormous molecular friction, low heat conductivity, and other factors.

The results obtained with aqueous solutions at atmospheric temperatures cannot be applied, and new tools must be found. It was fortunate that at the time when more attention was being paid to the application of

physical chemistry there was created the Geophysical Laboratory of the Carnegie Institution at Washington. The intimate study of the silicates became part of its proper domain. It at once began to develop the measurement of elevated temperatures with a high degree of accuracy, and to specialize in the most refined methods of microscopic investigation. Upon the use of these instruments of research it developed a structure of facts in the field of silicate chemistry which is unique, and which is a source of pride to American science. Its influence radiates into every field of ceramic technology.

It would be tedious to trace the gradual development of ideas in our field, and it might suffice to outline roughly some of the conceptions which we have reached at the present time.

In dealing with such raw materials as the clays we are realizing that we must concern ourselves more and more with the minute and ultimate structure, and less with the gross structure. We are gradually adopting the methods of the chemistry of colloids through the study of the grain size by means of the ultramicroscope, the absorption phenomena, kataphoresis, the determination of the hydrogen ion potential, electrical conductivity, the measurement of plastic and viscous flow, and other measurable factors. It would not be at all surprising if through such work we were enabled to bring about decided changes in the structure of certain of our clays, as for instance in the conversion of the partially set colloids of the carboniferous fire clays to plastic bonding materials, and in destroying the excessively colloid nature of our secondary plastic kaolins.

In the study of the dried and fired materials we are already at work in correlating all the physical properties, such as resistance to compression, tension, and transverse stress, the modulus of elasticity, density, porosity, volume changes, thermal expansion, thermal conductivity, electrical conductivity, etc. It is now generally realized that the minute structure of a silicate mixture is far less dependent upon the initial mineral composition than we thought, and more and more upon the heat treatment it has received. We know that porosity and volume changes are but rough criteria of the molecular changes, and that we must rely upon microscopic examination and the fixing of some function such as the relation between time-temperature and true density, or between time-temperature and thermal expansion. The determination of isolated constants will not yield the information we must have. The rapid extension of the application of the X-ray spectra which have been used in several ceramic problems promises to be a powerful aid in the identification of crystalline structures which develop upon heating, as for instance, to tracing the growth of mullite in porcelain. It is quite possible that such methods may assist in the production of the ideal electrical insulator for our high tension lines.

What has been said of the study of the fundamental properties of clay products applies also to glass and enamels for which we have available in addition a powerful and searching tool in the application of optical methods.

Portland cement has probably received the most thorough microscopic study of all the silicate products, and we know more about its structure; but much remains yet to be done in elucidating the hydration process and in examining the colloidal products which it yields.

Common to all of these industries is the study of the combustion processes, and the problems of uniform heat distribution. While we have accomplished much in this field a great deal remains to be done, particularly as regards the vital question of heat transfer and heat distribution.

This rough outline of the status of our knowledge pertaining to the technology of the silicates has been attempted since it is part and parcel of the subject of ceramic education. The latter, as is true of all other fields of technical endeavor, is in a state of constant flux and growth. This means necessarily that ceramic education should be in the hands of men who are sensitive to this progress, and are able to keep pace with it.

In this connection there is to be voiced the regret that with all of the activity which has prevailed in this field, there is available not a single text book which could be used to replace, at least in part, the lecture system by which the subject of ceramics is taught. This is a most unsatisfactory state of affairs since it places upon the teacher the burdensome and risky task of selecting from the mass of old and new data those fundamental facts which he considers to be the most vital. It cannot be denied that this is a reflection upon the technical workers in this field.

In this country we have provided for the collegiate training in ceramics, while in Europe the trade school has received more attention. We have made no serious effort to provide for those of the industrial workers who aspire to better things, but cannot do so by force of circumstances. We provide commissioned officers, but no sergeants and corporals. A good army needs both. There remains the question as to how this problem can be solved, and whether the university is justified in undertaking extension work.

Finally, we must not neglect to make mention of a part of the system of ceramic education represented by the research activities of the Federal Bureau, the Bureau of Standards, and the Bureau of Mines, which have done much to enrich the store of our knowledge, and undoubtedly will contribute much more in the future. They have played a unique and important part in the development of the industries, and have made a distinct place for themselves in the making of ceramic literature, and hence in education.

THE FUTURE OF CERAMIC EDUCATION[1]

By E. W. Tillotson[2]

It is fitting that the subject of ceramic education be discussed at meetings of a great ceramic technical society, and it is particularly appropriate that a symposium on the subject be held at this University on the thirtieth anniversary of the inaugural of ceramic instruction. For here has been established a department of ceramic engineering from which graduates have gone forth to become leaders in industry. It is clear, however, that any individual or institution in a position of leadership, cannot expect to maintain the advantage without continual effort for betterment. A convocation like the present one is an indication of the desire to train men even more satisfactorily for the growing needs of the ceramic industry, and represents real progress in education.

During these thirty years there has been created a new professional group, ceramic engineers, a uniquely American profession. This new group has more than justified the effort extended in its development, for the ceramic industry is one of the few really basic branches of manufacture in modern civilization. All industries, large and small, depend on some ceramic material for their very existence. Refractories, glass and ceramic materials of construction are essential in engineering. Many of these dependent industries have resulted directly from the developments of science, and probably all have benefited from scientific advancements. It is therefore important that the parent of all industries should bring its own science to the highest possible development, and should train an ever-increasing number of men in its technology, not only for the benefit of itself, but also of those other industries which employ ceramic products.

The requirements of industry for trained men in ceramics are not being supplied. Eleven American schools are doing useful work in ceramic education, but the field is so broad and the opportunities so varied that the need for still more ceramists is growing constantly. If it be assumed that about four hundred graduates in ceramic engineering are now engaged in the industry, it is believed that an additional eight hundred ceramic engineers would not satisfy the country's existing need for ceramic technologists. Men trained in ceramic technology are required in the laboratory for plant control, in the factory as operatives, in the business as executives and as technical salesmen, and in developmental work. This statement applies not only to those industries in which ceramic products are being manufactured, but also largely to those industries in which

[1] An address delivered at Ohio State University, Columbus, Ohio, on the Occasion of the Thirtieth Anniversary of the Founding of Collegiate Training in Ceramics, February 16, 1925.

[2] Assistant Director, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

ceramic products are used. For example, altogether too few of even the large users of fire brick, or of special refractories, have the ceramic engineer as a part of their organization. A pertinent illustration has been called to my attention recently: A copper-smelting company, which, for lack of expert ceramic knowledge within its organization, suffered constant and inexcusable loss. Similar instances in many other industries could be given, but the emphasis is upon the point that ceramic education extends beyond the production of ceramic materials and embraces as well the use of them.

The opportunities for men trained in ceramics indicate then the desirability of attracting a greater number of promising students and encouraging them to specialize in ceramic engineering. This result can be accomplished mainly through suitable and systematic publicity by the schools themselves as well as by the AMERICAN CERAMIC SOCIETY. Literature describing the fields of ceramics and setting forth the accomplishments of ceramic engineers and the opportunities for further achievement could be published and placed with professional advantage in the hands of prospective students.

It is not the purpose of this discourse to consider specific courses of instruction for the ceramic engineer. These courses can be and should be improved and standardized in so far as possible, and advantage should be taken of all existing agencies. It would be helpful to have direct cooperation with the Society for the Promotion of Engineering Education and to study the experience of the American Institute of Chemical Engineers in its revisory work in chemical engineering education.

In general, it is clear that the scope of these courses should be made more basically broad rather than more specialized, especially during the first two years. The importance cannot be overemphasized of more thorough instruction in chemistry, including organic chemistry as well as geochemistry, mathematics, physics and other fundamental sciences. The value of sound grounding in English and economics should not be overlooked. These essential subjects contain the basic principles of which engineering is the application and are considered to be irreplaceable in the foundation of an engineering education. Indeed, the discussion of clays and of ceramic materials in the light of these sciences constitutes "ceramics," the study of which, employing all the tools of science, is a responsibility of every department of ceramic education. Unless progress in the scientific aspects of a subject is maintained, not only are the efforts of its sponsors in the past nullified, but it fails in possible accomplishment. The saying of a certain ceramic manufacturer that, "In an age of progress, whoever clings to the methods of the past will soon find himself neglected and forgotten," is true of science as a technological practice. The particular courses devised and the methods of presentation, therefore, should be the

result of continued scientific investigations, carried on without the limitation of immediate industrial utility. Thus the importance of the several branches of chemistry and of other sciences can be evaluated and applied according to their weight in the curriculum. Such an atmosphere of research is advantageous not only in attracting prospective students, but also in its reaction on all the students. Only a few will devote themselves to research, but they will be more adequately trained in research method and the others will have a sympathetic understanding of research and its application.

Proficiency in research and in underlying scientific subjects is not, of course, the full purpose of engineering education. It is equally important that the graduate acquire knowledge by personal experience in the industry which he is about to enter. Coöperative training, which has proved of value in other branches of engineering, is equally available in the ceramic field, and its worth cannot be overestimated. Visits of inspection to plants are useful and important, but required employment in the factory during several months of each school year, for which credits would be allowed, should add materially to the fitness of the graduate for his professional career. This type of training is included to a limited extent in the curricula of some of the ceramic schools. It should be encouraged, systematized, and extended in its scope and utilized as an important aid in ceramic education.

In surveying ceramic literature, one is impressed with the lack of adequate treatises by American authors which can serve as text books in ceramic schools. The literature is scattered widely, in periodicals and in institutional and governmental publications. Such a condition cannot exist indefinitely; and while the student should ever be familiar with the original sources of the literature of his subject, the time must come when that literature is inconvenient for class room use. The appearance of carefully prepared treatises on all branches of the American ceramic industry, especially on heavy clay products, refractories, whiteware and porcelain, and glass, would be a welcome addition to technologic literature. It seems that such literature is necessary if ceramic education is to attain its highest efficiency, and if it is to fulfill the purpose of its founders. One is inclined to wonder why, after thirty years of achievement, at least a comprehensive work on the scientific principles of ceramics has not appeared from any American author. The lack of such works may perhaps be regarded as a reflection on the solidarity of ceramic education in this country. Certainly the production of such treatises should receive sympathetic encouragement from the officials of the schools, if the importance of ceramic engineering is understood by them.

A united and sustained plan of publicity giving information concerning the scope and purpose of ceramics and ceramic engineering is an im-

mediate need to prepare for the ceramic education of the future. Such a program should utilize every available means to inform people generally of the relation of the ceramic industries to their every-day experience, of the accomplishments of the ceramic engineer, and of the opportunities for trained technologists. It should not cease until the gospel of ceramics has been carried into every home in the land, so that the high-school student as well as the average citizen will know as much concerning it as he does of other professions. If such a plan can be carried through, there can be little doubt that the desired students will be found, that the demand for engineers trained in ceramic technology will be multiplied, and that ceramics as a science and as a profession will reach the high plane and receive the recognition that the importance of it in our civilization justifies.

ADDRESS OF THE RETIRING PRESIDENT[1]

By R. D. Landrum

It is somewhat of an anachronism that the President of the American Ceramic Society who will preside over this Meeting, celebrating the 30th anniversary of collegiate education in ceramics, did not have the advantage of a course in any of these ceramic schools. His ceramic education, like that of a large proportion of our members, has come from a source not pictured or mentioned by Professor Watts (see p. 112). When this first ceramic school was but three years of age, the American Ceramic Society was created, and in its publications there is available to the whole world a large proportion of today's ceramic knowledge. From these writings and from attending the meetings of the Society, your President and an ever increasing host of others are obtaining a ceramic education. I wish I could make you realize what a tremendous influence the comparatively few ceramic graduates have had through the American Ceramic Society —and the work goes on.

It is indeed a pleasure to stand before you today as president of this wonderful Society and to be able to state that the enlarged activities of the American Ceramic Society are no longer an experiment. They have proved a complete success.

Our having a full time Secretary-Editor, advertising manager, and a business office here at Columbus has been of great advantage to us, and it is especially gratifying that during 1924, we lived well within our income. There is a balance on the right side of the ledger of almost three thousand (3000) dollars.

The *Journal* and the *Bulletin* have been such that we can well be proud.

[1] Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, Feb. 16, 1925. (General Session.)

Our original papers have been largely quoted in other technical journals, both here and abroad.

Our work in the preparation of Bibliographies is going on. Those on silica refractories and magnesite refractories are completed and distributed.

It is regrettable that our total membership decreased last year. A part of this decrease is healthy. Some of those who dropped their membership on account of the increase in dues, by that very act showed their ineligibility. We do require that each member must be sufficiently interested. The influx of new members, however, should have been greater. It is the earnest belief of your president that our policy this year of not campaigning for new members has been harmful. No enterprise can succeed without a sales department. The membership committee is our sales department. It did not function this year.

One of our aims next year will be to make it impossible for any one interested in the silicate industries not to know what this SOCIETY has to offer them, and that we want them as members.

On the other hand, the business of handling the advertising in the *Journal* merits our enthusiastic praise. The returns from advertising have increased greatly in spite of the fact that we have altogether dispensed with assistance from advertising agencies. The members can help us next year in further increasing our income by indicating to their suppliers the advantage of advertising in the *Journal.*

The team-work of the active workers among the members has been very gratifying, and I must emphasize especially the very efficient work of our Secretary, the Board of Trustees, the Divisional and Sectional officers, many of the committees, and the very efficient workers in the Secretary's office.

We are under obligations, too, to the companies employing our trustees, the committeemen, and workers in our sections and divisions for the time given so graciously for SOCIETY work. We fully appreciate this and thank them.

In this address of mine, I want to outline briefly the developments in the ceramic industries during the past year and to call attention to the individual members of a change that might be made in our general policy to accelerate our accumulation of fundamental data. This work will largely have to be done by men trained for scientific work of the highest type and, at the same time, thoroughly familiar with the problems of each individual industry.

In my address last month "What the Industries Want from the Ceramic Scientist," I tried to define the term "Ceramic Scientist." In groping to differentiate between the Ceramic Scientist and the Ceramic Engineer, I said that the difference was analogous to the difference between the industrial chemist and the chemical engineer. The editor of *Chemical*

& Metallurgical Engineering has just coined the exact word I wanted. He has taken the first part of the word "scientist," one learned in science, and the last part of the word "technologist," meaning one skilled in technology, to make the new word "scientologist."

The ceramic scientologist is the man required for this work.

In most of the discourses on the subject of research, we find the speaker trying to define and distinguish between pure and industrial research. Of late, they have always ended with the statement that it is difficult to say where one leaves off and the other begins. It is the development of this scientologist in industry that has caused this trouble in definition.

We have pictured in the back of our minds the scientist as an absent-minded individual, careless of everything except the small, rather abstract field in which he is working. In fact, in our frankest moods, he was exactly the kind of a person we did not want to be.

To quote from the editorial, "He was considered as a being apart from ordinary mortals, unpractical and visionary."

Even before the war, perhaps largely through that great interpreter, Robert Kennedy Duncan, this idea in our country began to change. Pure scientific research began to find itself in industry. The practical men in the industries began to teach the scientist in the university the finesse of their processes, and the scientist began to teach the industrial man scientific methods and as the editorial mentioned goes on, "Science today is the helpmeet of industry; and the scientist who hopes to 'arrive' must have for his purpose in life the introduction of changes that will speed production, reduce costs and improve quality; he must devise applications and perfect processes for the utilization and conservation of resources and man power; he must benefit industry and, in doing so, benefit humanity.

"This consummation of ideals may not be his immediate objective, but it indicates the purpose of his work. He cannot dissociate himself from the ultimate object, although this must not be allowed to influence actions or deflect the course in the direction of the scientific ideal, the discovery of fact.

"The gap between the laboratory and the plant has narrowed so much of late that a bridge between the two is possible, whereby the scientist can emerge from his seclusion and, seeing the application of his researches, take a scientific interest in production problems."

The ceramic scientologist will be "up to the minute in theoretical knowledge," and skilled in scientific method, but with a true appreciation of the necessity of using the equipment economically available and temperamental labor actually at hand to accomplish his results.

"Sound practice is only theory tempered by compromise."

This bridge that has connected the blaring temple of industry with the quiet chambers of the laboratory and library, has had men passing

over it both ways. Not only has the scientist passed over this bridge to the joy of exerting scientific method in influencing men and compelling machinery and materials to act according to scientific laws; but the man whose undergraduate work has been in this bedlam of noise and profit has also crossed this bridge in a happy and enthusiastic procession of fellow workers to the laboratory and the library.

Just look over the list of members in our own SOCIETY, and see how many of them have no degrees after their name. Come into our Division meetings tomorrow, and hear practical shop talk in the most technical language. Look over the papers published in our *Journal*, and see how many of them ring true with exact knowledge of the industry itself.

The superintendent of one of the plants with which I am connected has a paper tomorrow showing this drift of practical men toward things scientific. His subject is "The Swan Song of the Rule-of-Thumb Enameler."

Look over the classified list of the 15,000 members of the American Chemical Society, and see what a large proportion of them are office and plant executives. Look at the type of journals you will find on the desks of the purchasing agents of our industries. These men are deeply interested in things technical. That is one reason our *Journal* is such a good advertising medium. In the club cars of our transcontinental trains, find how well informed on technical subjects are your fellow travelers. And these men are the very sinews of our industrial life, the managers and the salesmen.

Many are becoming eligible to what our Dr. Arthur D. Little calls the "fifth estate," "composed of those having the simplicity to wonder, the ability to question, the power to generalize, and the capacity to apply."

No wonder the days of secrecy are over. The doers in the plant and laboratory today are speaking the same language. Openmindedness is becoming a part of common sense.

The technical societies and their journals are having much to do with this general give-and-take educational process, and we should be proud indeed of the part the AMERICAN CERAMIC SOCIETY is having in it.

We have united in one common fold the silicate industries, and our responsibility is great. Unlike the other societies—though our field is probably the oldest and although over 80% of this old earth crust is our domain—the fundamental knowledge that we have gathered together is very meager indeed. And this is to be expected of a field as old as ours.

The art of such industries was fairly well developed through generation after generation of artisans long before science was known. These artisans thought, and many of the older ones yet among us believe, this secret knowledge, handed down from father to son, this to be their stock-in-trade.

Their minds were adamant against either imparting it to others or letting a single change slip in.

It is difficult to realize that when Josiah Wedgewood produced the Plymouth vase, Dalton's theory was unknown, and it was thought that phlogiston escaping from the coal fired the ware!

And yet, Mellor says of this versatile man, the inventor of the pyrometer as well as the creator of the Plymouth vase, "Wedgewood's private notebooks teem with records of experiments in ceramic chemistry which would be creditable were they published tomorrow."

We must in some way find means to add to this fundamental knowledge of ours. We have advanced far in art and in engineering. It is interesting to note that Dr. W. E. S. Turner's report of his visit to this country last year uses hardly more than a single page to tell of the scientific development of our glass industry in the last four years and fifteen pages to tell of our engineering advancement.

Our achievements in the mechanical processes of glass manufacture are the marvel of the world. Five plants are now making sheet glass by the Fourcault process, and the commercial success of the Ford continuous flow method for making plate glass is astounding. Thanks to our luxury-loving automobilist, practically every manufacturer of plate glass has made or is now making extensive enlargements. The hand-blown window glass industry has almost disappeared. The fireless leer is coming into its own. The glass pot is largely being replaced by continuous tank furnaces. Torpedo shaped furnaces have appeared—eliminating the troubles caused by the molten glass cooling in the corners of the rectangular furnace. Even tumblers and other light ware are being produced in automatic machines. Mr. Brownlee's scheme of super-insulation of furnaces is an interesting development. We are moving toward mechanical perfection.

On the artistic side of the glass industry we are progressing, too. The old heavy cut glass is being replaced by lighter shapes of beauty and color—even Dr. Turner had to admit our esthetic improvement.

Many of the plants are maintaining laboratories, and the results of the work of technically trained men both in these laboratories and in the plants themselves are plainly shown in their products today. But the contributions of these to our general fund of knowledge are bound to be slow. Most of the results obtained in these laboratories are of immediate commercial advantage. It is scarcely to be expected that they will be furnished to competitors.

It is, I believe, the next task of our SOCIETY to arrange some sort of a scheme where more research work of a more or less fundamental nature can be carried on. A scheme that will allow our Divisions to *initiate* as well as *report* research.

In the enameling industry the same thing is true. We have improved greatly the iron base that we use—our cleaning processes, our furnaces. Our plant routine is becoming reduced to order.

There have been many new enameling plants erected during the past year, three very large ones. Probably the most novel installation this year, and one which makes a long step in the history of enameling, is the designing of a continuous plant by Alvin Sherman of Detroit. This plant will enamel the stove parts for the Detroit Vapor Stove Co. in a process that is almost 100% continuous. Ware will pass singly through the various tanks in the cleaning process, through the drier, and be delivered to the dipper for first coat application. The firing is done in a continuous electrical furnace of unique design, a circular furnace some 15 feet in diameter, with a revolving bottom. This bottom is a net-work of nickel chromium points, and on these points is placed the ware to be fired. There are two openings in the furnace, side by side, one for the introduction of the ware, and the other for taking it out. The rest of the process, coating with white enamel, drying and firing, is also continuous. Three of these circular revolving furnaces are used, one for each coat of enamel.

During the last year, much has been done in improving furnaces in the enameling industry. The electrical furnace is gaining headway. Another type of continuous furnace is now in use at Huntington, W. Va., in the plant of the Armstrong Mfg. Co.

There has been quite a development also of electrical door opening devices, lever turn tilting tables, spraying machines, electrical brushing machines, movable dipping tubs, telescopic sieves and speed forks.

My prediction is that the development in this industry over the next five years will be mainly toward complete continuous enameling processes, and the production of the enamel frit in several centers in sufficient quantity so that it can be produced economically with the technical control necessary.

The Enamel Division has taken to itself in a moderate degree, some initiative in planning and carrying through research work, mainly regarding plant and process problems. Just this year they have raised quite a sum for research. A precedent, mind you!

Nineteen hundred twenty-four was a good year in the Refractories Industry. Although no new plants have been built, many improvements have been made in those existing. There is a tendency toward consolidation.

Many mechanical improvements have been made in this industry, too. Machine pressing of both fire clay and non-fire clay refractories has received greater attention. Dressing machines have been developed. An automatic spalling test furnace was constructed and made a success.

Much attention has been given to drying problems. Two new types of drying pallets are interesting, one of enameled iron and the other of plaster of Paris.

The refractories industry has been fortunate in that the Refractories Manufacturers' Association has been entirely "sold" to the necessity for coöperative research.

On account of the boom in the building trades, this last year has been an unprecedentedly good one in those of our industries depending upon these trades. The value of the products in these industries reached a total far exceeding that of any other year; something like five hundred million dollars. The business, too, was profitable in spite of the fact that competition brought prices down to a point where profit seemed impossible. This profit was the result of the gradual shift from hand power to horse power through continuous processes of firing, conveying and drying.

Almost ten thousand million common bricks were produced. And think! They sold at a profit when the Chicago price was $12.00 a thousand. When we consider that by hand labor it costs as much to lay a thousand bricks as it does to lay them down on the job, we begin to realize the part that quantity production and effective processing has done.

There were almost half as many more face brick manufactured last year than there were five years ago. Many paving brick companies have diverted a part of their capacity to making face brick.

Indicative of the alertness of the executives of these Heavy Clay Products Industries, we note with approbation the formation of the Clay Institute. This was, I believe, the result of the definite recognition on the part of these executives that heavy clay products are a highly technical problem. As Francis T. Owens, chairman of the Heavy Clay Products Division says, "The production of heavy clay products is considered by some today just as technical as the manufacture of steel. The fact that this great truth is becoming more and more recognized, means that we are on the threshold of wonderful developments." And remember, it is not long since it was commonly believed that "anybody could make and fire brick."

Our Heavy Clay Products Division should see to it that our SOCIETY gives all the assistance possible. They should see, too, that this Institute joins with us in our Ceramic Institute when this is formed, and thus have the benefit of a general guidance. There is so much to be done that all must avoid duplication of effort.

In the White Ware Industries the tendency is also toward continuous processes. The outstanding development probably being the complete tunnel kiln plant, including bisque, glost and decorating, such as the new

Homer-Laughlin plant. The floor tile has shown rapid growth, and chief among its developments has been the use of conveying systems and more automatic processing. In the electrical porcelain field automatic finishing machines for line insulators were developed. In the manufacture of sanitary ware the further development of the casting method was one of the big features. One plant has developed a continuous conveyor system on which the casting is done. Humidity control plays a very important rôle in this system. The tendency as in other fields has been toward continuous driers. Larger and larger units are being cast in one piece. The increase in the general adoption of tunnel kilns in the whole white ware industry is very gratifying.

Most of us are radio fans; therefore, I know you were pleased, as I have been, to see this year several contributions to the advancement of radio come from our industries: The use of both glass and porcelain for insulating variable condensers. This insulation has changed them from "low loss" to no loss. The glass socket has just been introduced, and most unusual of all, a pottery radio horn which our friend McAfee manufactures and calls "The Auditorium."

The various individual plants in these finer clay industries, of course, are carrying on technical research work, and are very generous in sharing the results of much of this with each other, through the Terra Cotta, and White Ware Divisions of our SOCIETY. Most of this, however, I believe, is in finding the application of truths already discovered to their own particular needs. We must, therefore, arrange some program so that *new truths* can be discovered; and, happily, we have two Divisions to supply the initiative.

How often every single one of us threading our way through experiment after experiment are baffled from the lack of fundamental data. We are groping in the dark. What a very small sum would have to be spent in proportion to other forms of insurance so that in the future more data will be available. Dr. Washburn used the figure in outlining the plans for the refractories research, of 10% of the fire insurance premium now paid by each industry. This seems ridiculously small when we think of the results it could accomplish.

The other day, I read Bruce Barton's article on "Habits" in the last number of *Good Housekeeping*. He speaks of an interview with "a great scientist and inventor" which so beautifully illustrates a point I want to make, that I'll quote him exactly.

"The inventor began his talk in this novel fashion."

"Did you ever read Fabre's book on the Wasp?" he asked. "The hunting wasp is one of the most interesting of the species. It lives its brief summer existence. As fall draws near, it catches two big beetles and paralyzes them with a sharp sure thrust. Just one thrust in precisely

the right spot. No fumbling, no mistakes. Between the two beetles, it deposits its eggs, covers them, and having fulfilled its life work, lies down and dies.

"In the spring, its children are hatched by the warmth of the sun. On either side of them is the food that will carry them through to self support. They eat, grow and fly away. They live their summer lives and in the fall they repeat the story of their parents. A wonderful story it is. A marvelous instinct it is that tells them just what beetles to select; just how to make that unerring thrust. Yet here is the tragedy of it: When the ruins of Pompeii were uncovered, the work of the hunting wasp was found—two beetles stung in precisely the same faultless fashion, laid on their backs in the unvarying way, wound round with the covering which has not changed in the slightest since the world began.

"No improvement in all the ages. No single evidence of thought. Merely blind instinct repeating dutifully the perfections and imperfections of all that have traveled before. "That," said the scientist, "is typical of the great majority of us humans. We perform well enough the necessary functions of life, but there is no thinking in our processes—only instinct. We move in grooves. We are creatures of our yesterdays. Not once in a year do most of us sit down quietly and say to ourselves, 'I am going to think out a new path and pursue it. I am going to see whether there is not some other way to do this thing than the way in which it has always been done.' "

No one can accuse the AMERICAN CERAMIC SOCIETY, as far as we have gone, of "moving in a groove." Some of us were among those that started this SOCIETY with the one idea of injecting into the industry a little faith that science would assist even in brick making. Then the SOCIETY'S scope enlarged to include all clayworking. Then the technical men from *all* the silicate industries were invited to become one with us. We thus changed the definition of the word "Ceramics." Later the annual *Transactions* was changed to a monthly *Journal*, and then the *Bulletin* added. The membership has grown to over two thousand. Seven societies in one—each Division's work being nearly self determining. We have grown vigorously, but not in any way much different from other technical societies.

We do semi-annually have the joy of keeping up friendships with others whose problems are ours, and contribute our bit each year in papers and discussions. Then we go back to our various jobs of making certain that brick, or kitchen utensils or dishes or bottles are fit to bring profit to our employers.

The other societies are doing these same things. Isn't it time we made another move forward?

Let each Division at this very meeting organize to initiate research. Each one of them can take definite steps to find out what can be done.

One Division can best work through the trade association of its industry. With some of the Divisions, the work in *their* trade association is well under way. Get into this work. Let their research program at least have the counsel of your Division.

Some of the Divisions will probably find it necessary to organize in some other way. Let's make a start.

A program of real research will need funds. These can be obtained. Ambrose Swasey, through other societies, has created an Engineering Foundation of half a million dollars for research work in engineering. Other philanthropists can be found. And if they cannot, and if your industry will contribute to "insurance for scientific advancement" one-tenth the amount they pay for fire insurance—great things can be done. But this movement must be organized, and remember in organizing that the fundamental truths which must be searched for by one Division are very probably the same truths needed by every other Division. Let's organize to avoid duplication.

During the war, science developed with extraordinary rapidity, because of the formation of groups of the most highly competent scientists in the world, and because of the creation of effective channels between these groups.

The AMERICAN CERAMIC SOCIETY can duplicate this performance in peace times.

Our job this year is to see to it that an individual Research Institute is organized for each industrial group and a general Ceramic Institute to connect them all.

ANALYSIS OF DATA REGARDING CERAMIC EDUCATION[1]

BY ARTHUR S. WATTS

1895—1 school—1 teacher—15 students—$2500 salary budget—$5000 equipment and maintenance budget.

1900—2 schools—4 teachers—less than 25 students.

1925—10 schools granting ceramic degrees and 2 schools training ceramic art teachers—41 teachers—$108,500 amount salary budget—$12,760 annual new equipment budget—value of ceramic teaching plants $500,250.

In 1900 there were less than 25 enrolled ceramic students—in 1925 there are 536 enrolled ceramic students.

In 1900 there were no students graduated with ceramic degrees—in 1925 there are 493 graduates. It was not possible to obtain data regarding the occupation of graduates of all the ceramic schools but of 336 graduates reported 4% are in enamel industry, 5% are in the glass industry, 16%

[1] Presented at the Annual Meeting, Columbus, Ohio, Feb. 16, 1925. (General Session.)

are in the heavy clay industry, 12% are in the refractories industry, 8% are in the terra cotta industry, 18% are in the white ware industry, 6% are in research laboratories or teaching, 9% are in unlisted ceramic industries, 14½% are out of ceramics and 7½% are deceased or no record.

In thirty years we have produced less than 500 graduates, have acquired a plant investment of $500,000 and are spending $100,000 per year for teachers. This for an industry with a capital of $1,055,000,000 and an output which has a value of $800,000,000 per year. The fixed investment for the technical growth of the industry represents .05 of 1% of the value of the invested capital and the salary investment for education represents .012 of 1% of the value of annual output.

Survey of Ceramic Departments of the Universities

The Ohio State University

Founded 1895. Promoted by Dr. Edw. Orton, Jr. and Ohio ceramic industries.

Original appropriation from State Legislature: For salaries $2500; for equipment and maintenance for one year $5000.

Value of present teaching plant and equipment—$45,000.

Present sources of maintenance, State appropriation.

Distribution: salaries $10,450, new equipment $1900, maintenance, General University Fund.

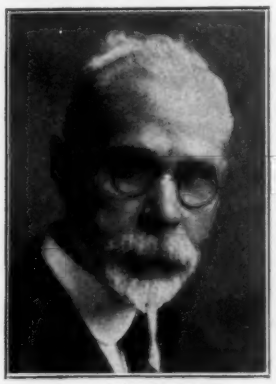
Original personnel—Prof. Edward Orton, Jr.

ARTHUR S. WATTS.

Lord Hall, Ohio State University.

Present personnel—Prof. Arthur S. Watts, Prof. R. C. Sloane, Instructor, Jas. T. Robson, Mechanician, Jno. C. Lysatt, Student Asst. F. C. Westendick.

Registration of students by years—1895–96—15; 1897—10; 1898—12; 1899—14; 1900—17; 1901—26; 1902—33; 1903—30; 1904—35; 1905—32; 1906—45; 1907—63; 1908—54; 1909—54; 1910—61; 1911—44; 1912—34; 1913—42; 1914—49; 1915—65; 1916—63; 1917—49; 1918—39; 1919—40; 1920—36; 1921—37; 1922—60; 1923—73; 1924—96; 1925—101. Total 1329.



CHARLES F. BINNS.

Distribution of graduates: Art 0; Enameled Metals 3; Glass 14; Heavy Clay Products 27; Refractories 22; Terra Cotta 19; White Ware 36; Research Bureaus and Teachers 13; Miscellaneous Ceramics 15; Outside Ceramics 23. Deceased and No Record 21. Total graduates 193.

New York State School of Clay-Working and Ceramics

Founded February, 1900.

Original appropriation by New York State Legislature: $20,000 for establishment, equipment and one year's maintenance.

Value of present teaching plant and equipment—$40,000 as appropriated.

Alfred University.

Present sources of maintenance, State appropriation only.

Distribution: salaries $15,370.00, maintenance $4718.88.

Original personnel—Prof. Chas. F. Binns, Prof. Blanchard.

Present personnel—Prof. Chas. F. Binns, Prof. A. I. Andrews, Prof. A. H. Radasch, Prof. Marian Fosdick, Prof. Catharine Nelson, Instructor Jno. Voorhies.

Registration of students by years—1907—10; 1908—18; 1909—23; 1910—35; 1911—34; 1912—35; 1913—47; 1914—39; 1915—39; 1916—46; 1917—40; 1918—59; 1919—53; 1920—85; 1921—103; 1922—97; 1923—111; 1924—129.

Total graduates 127.

Rutgers College and the State University of New Jersey

Founded 1902. Appropriation from State Legislature. Organized and functioning in 1903.

Original appropriation: $12,000 by State Legislature at the solicitation of a group of prominent clayworkers.

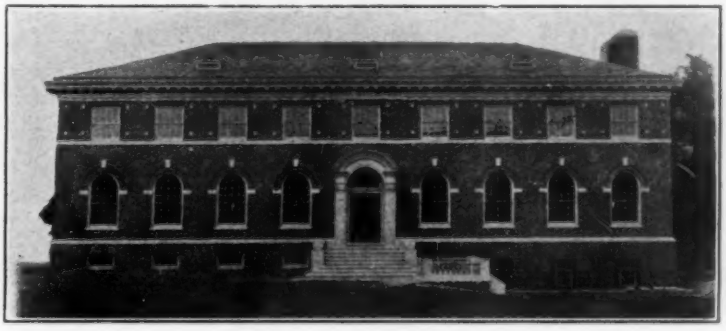
Value of present teaching plant and equipment—$150,000.

Present sources of maintenance, State appropriation.

Present maintenance fund $18,000 per annum. Distribution: Salaries $10,800, supplies and maintenance $5400, new equipment $1800.

Original personnel—Prof. Cullen W. Parmelee.

GEORGE H. BROWN.



Rutgers College.

Present personnel—G. H. Brown, Professor of Ceramics and Director, W. L. Shearer, Assistant Professor, Malcolm B. Catlin, Instructor, E. J. Vachuska, Instructor.

CULLEN W. PARMELEE.

Registration of students—1925—30.

Distribution of graduates: Data not available.

University of Illinois

Founded 1905. Original promoters, Prof. C. W. Rolfe; Wm. Hammerschmidt; F. W. Butterworth; John Stipes; W. D. Gates; A. W. Gates; Dr. A. L. Converse; D. V. Purington.

Original appropriation by State Legislature: $5000 for 2 years' maintenance.

Value of present teaching plant and equipment—$30,697.28.

Present sources of maintenance, Illinois Legislature.

Distribution: salaries $19,658.40, new equipment $4060.74, maintenance $8652.88.

Ceramics Building, University of Illinois.

Ceramic Engineering Station: Distribution of present maintenance fund: salaries $2478.35, new equipment $864.89, maintenance $1254.90.

Original personnel—Prof. C. W. Rolfe, R. C. Purdy.

Present personnel—C. W. Parmelee, Professor and Head of Dept., R. K. Hursh, Associate Professor, A. E. R. Westman, Research Associate, T. N. McVay, Instructor, E. G. Bourne, Potter, R. T. Watkins, Assistant, T. J. Wilson, Assistant potter, J. H. Cain, Mechanician.

Northern Illinois Public Utilities Research assistants: E. P. Wright, W. H. Pfeiffer, A. J. Paul.

Registration of students by years: 1905—1; 1906—5; 1907—17; 1908—17; 1909—16; 1910—28; 1911—47; 1912—71; 1913—80; 1914—75; 1915—65; 1916—42; 1917—23; 1918—22; 1919—47; 1920—40; 1921—72; 1922—66; 1923—82; 1924—89.

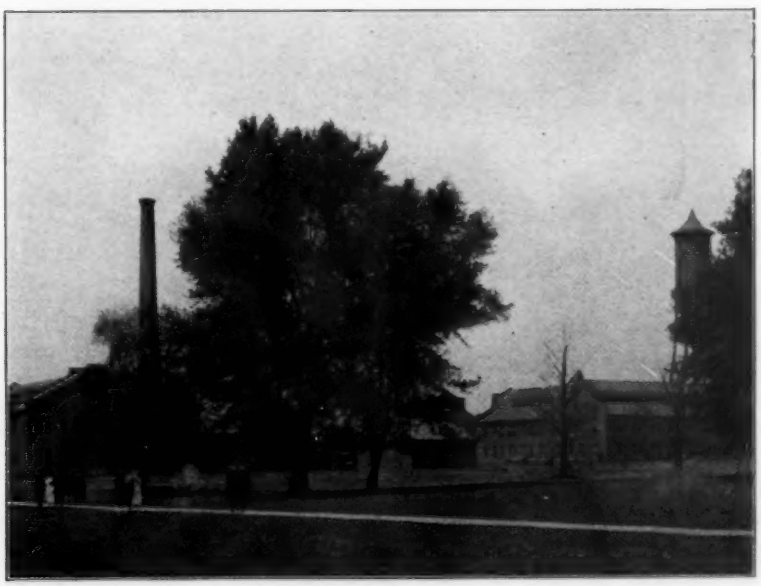
Distribution of graduates: Art 0; Enamels 8; Glass 2; Heavy Clay Products 16; Refractories 11; Terra Cotta 6; White Ware 22; Research Bureaus and Teachers 7; Miscellaneous Ceramics 13; Outside Ceramics 24; Deceased 5. Total graduates 114.

Iowa State College

Founded 1906 by the Iowa Clay Products Manufacturers Association.

Original appropriation by State Legislature.

Value of present teaching plant and equipment—$31,550.



Iowa State College.

Present sources of maintenance, State appropriation.
Distribution: salaries $11,800, new equipment $500 each year.

PAUL E. COX.

Original personnel—Prof. Samuel Byer, Prof. Ira Williams.

Present personnel—Associate Prof. Paul E. Cox, Asst. Prof. D. A. Moulton, Instructor, Mary L. Yancey.

Registration of students by years: 1910–1911—11; 1911–1912—6; 1912–1913—6; 1913–1914—4; 1914–1915—4; 1915–1916—9; 1916–1917—7; 1917–1918—6; 1918–1919—5; 1919–1920—3; 1920–1921—3; 1921–1922—6; 1922–1923—8; 1923–1924—20; 1924–1925—35.

Distribution of graduates: Art 0; Enamels 3; Glass 0; Heavy Clay Products 7; Refractories 3; Terra Cotta 0; White Ware 1; Teachers 1; Miscellaneous Ceramics 2; Outside Ceramics 2. Total graduates 19.

University of North Dakota

Founded 1910. Established by and under direction of Dean E. J. Babcock, College of Engineering.

University of North Dakota.

Original appropriation by State.

Value of present teaching plant and equipment—$20,000.

Present sources of maintenance, State appropriation.

Original personnel—E. J. Babcock, Margaret K. Cable.

Present personnel—E. J. Babcock, Dean College of Engineering, Margaret K. Cable, Assistant Professor.

Registration of students by years—About 60 per year.

No degrees given.

MARGARET K. CABLE.

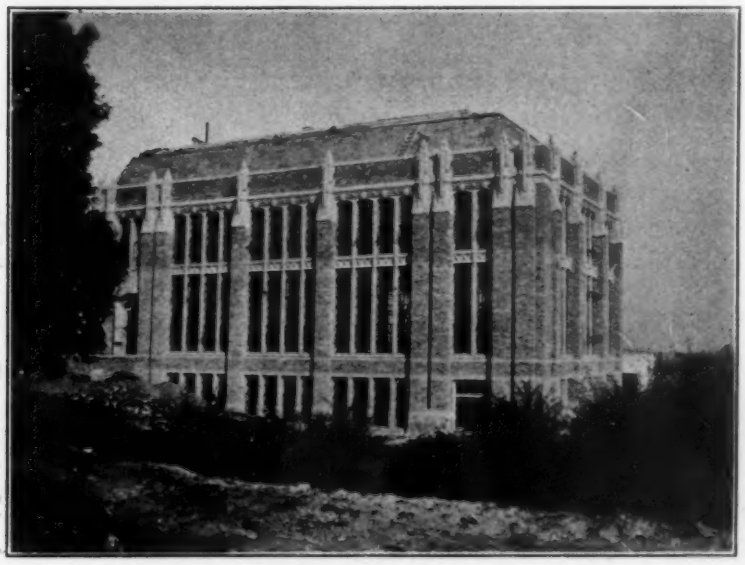
University of Washington

Founded 1918. Original promoters, Dr. D. A. Lyon, U. S. Bureau of Mines and Dean Milnor Roberts, University of Washington.

Original appropriation from current University funds.

Value of present teaching plant and equipment—$58,000.

Present sources of maintenance, annual appropriation by State plus U. S. Bureau of Mines Research fund. Distribution: salaries $4000, new equipment and maintenance $3000.



University of Washington.

HEWITT WILSON.

Original personnel—Ira A. Williams.

Present personnel—Hewitt Wilson, Professor, J. R. Gedvetz.

Registration of students by years—2 graduate students, 2 seniors, 2 juniors, 2 special, 4 electives.

Distribution of Graduates: Art 0; Enamels 0; Glass 0; Heavy Clay Products 2; Refractories 2; Terra Cotta 2; White Ware 0; Research Bureaus and Teachers 0; Miscellaneous Ceramics 1; Outside Ceramics 0; Total graduates 7.

University of Saskatchewan

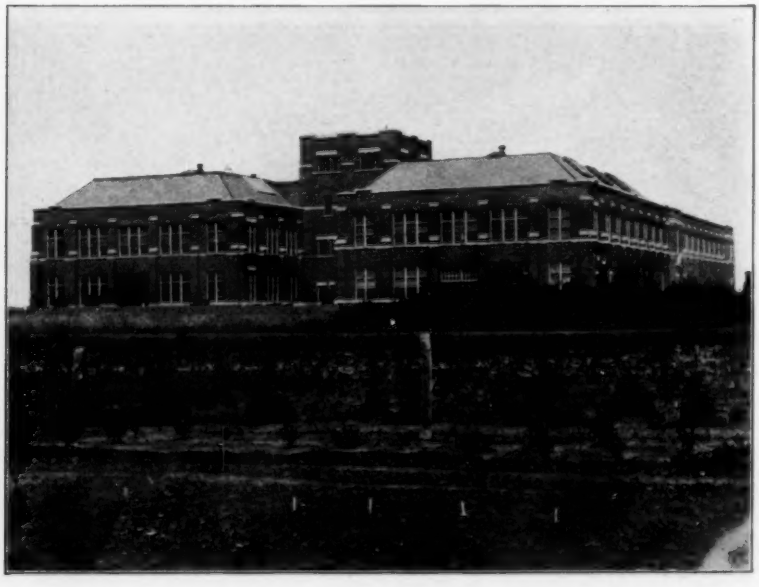
Founded 1921 by the University in conjunction with the Provincial Department of Industries.

Original appropriation—Provincial grant for salary and equipment.

Value of present teaching plant and equipment—$30,000.

Present sources of maintenance $6000 from University for salaries, $1500 for laboratory expenses and a labor fund.

Original personnel—Prof. W. G. Worcester.



University of Saskatchewan.

Present personnel—Prof. Worcester, laboratory Assistant W. H. Phipps.

Registration of students—1st year ?; 2nd year 6; 3rd year none; 4th year none.

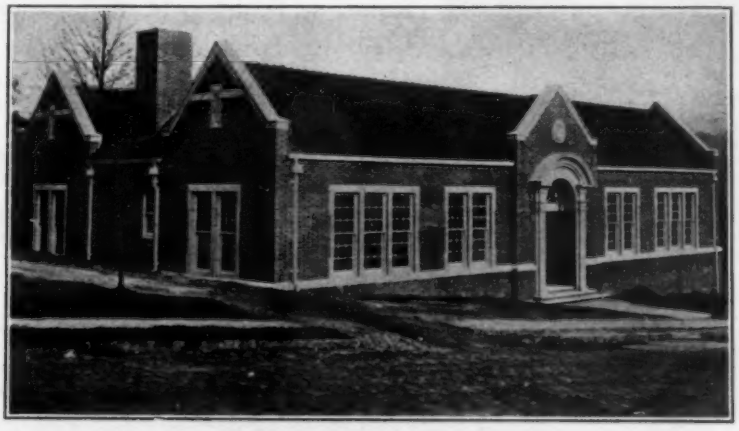
Distribution of graduates: Refractories 1; Heavy Clay Products 1; Total graduates 2.

WOLSLEY G. WORCESTER.

Georgia School of Technology

Founded Feb. 1, 1924. Promoters, Dr. M. L. Brittain, Central of Georgia Railway; B. Mifflin Hood Brick Co.

Original appropriation $30,000 donation for building, etc., by the ceramic industries of Georgia and $10,000 annual appropriation by the State.



Georgia School of Technology.

ARTHUR V. HENRY.

Value of present teaching plant and equipment—$40,000.

Present sources of maintenance, State appropriation of $10,000 per year. Distribution: salaries $4200, new equipment $2800, maintenance $3000.

Original personnel—Dr. A. V. Henry.

Present personnel—Dr. A. V. Henry, Mrs. J. B. Hosmer.

Registration of students by years—Sophomore only represented—4.

The Pennsylvania State College

Founded 1922 by Board of Trustees.

Original appropriation was by State Legislature—$5235.

JOSEPH B. SHAW.

Value of present teaching plant and equipment—$10,000.

Present sources of maintenance, State appropriation.

Distribution: Salaries $4000, new equipment $700, maintenance $535.

Original personnel—Prof. Joseph B. Shaw.

Present personnel—Prof. Joseph B. Shaw.

Registration of students by years: 1 Junior, 6 Sophomores, 4 Freshmen—Total 11.

Pennsylvania State College.

Newcomb College School of Art

Pottery, molding and decoration started in 1896 by Mrs. Josephine Newcomb, Dr. B. Dixon, E. Woodward.

Original appropriation was donation by Mrs. Newcomb.

Value of present teaching plant and equipment—$25,000.

Present sources of maintenance, sale of pottery $12,000, school fund for instruction $2500.

Original personnel—Ellsworth Woodward, Mary G. Sheerer, Joseph Meyer.

Present personnel—Ellsworth Woodward, Mary G. Sheerer, Joseph Meyer, Vincent Axford, Chemist.

Registration of students by years—1923–24, 51 students.

North Carolina State College

Authorized by Legislature January 1923. Organized September 1924. Promoter, Dr. W. C. Riddick, Dean of Engineering.

Original appropriation by Legislature, $25,000.

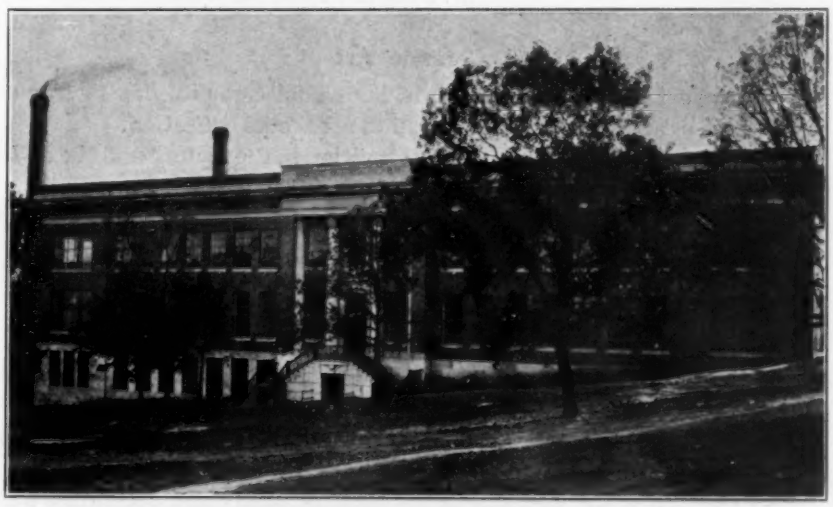
Value of present teaching plant and equipment—under construction.

Original personnel—Prof. A. F. Greaves-Walker, Head of Dept., K. W. Reece, Student Assistant.

Present personnel—A. F. Greaves-Walker, Head of Dept., K. W. Reece, Student Assistant.

Registration of students by years—4 Freshmen, 2 Sophomores, 1 Junior, 1 Senior, 30 Short Course Students, 42 Correspondence Students for College Credit.

ARTHUR F. GREAVES-WALKER, North Carolina State College.



Page Hall, Mechanical Engineering and Ceramics Building at North Carolina State College, Raleigh, N. C.

THREE GREATEST ACHIEVEMENTS DURING THE PAST THIRTY YEARS

We all recognize that the progress in the field of ceramics during the past thirty years far exceeds that of any similar period in its history but unless some inventory is taken it is doubtful if many of us will fully realize what wonderful strides have been made.

The enormous field included by the ceramic industry makes it practically impossible for any single individual to make a fair and unbiased choice of the three chief attainments of the industry and it seemed wise therefore to solicit opinions from recognized leaders of the various ceramic groups and by analysis of the data presented arrive at a decision.

The Chairman of each Division of the AMERICAN CERAMIC SOCIETY was therefore requested to indicate what he considered the three most important achievements in his particular field of ceramics. The replies are listed below in brief form. A survey of the data brings us no nearer our objective since each field has attainments peculiarly its own.

It would be unfair to make any classification and hence none will be attempted.

Terra Cotta Industry

1—The tunnel kiln which gives a more uniform product and shortens manufacturing time.

2—The introduction of color and enamel work.

3—The rust proof anchor and the expansion joint.

W. D. GATES, *Chairman*, Terra Cotta Division.

Ceramic Art

1—Improvement in public taste in household ceramics due to trained supervisors of art in public schools and to art school education.

2—More coöperation between the technician in the factory and the artist in the studio.

3—Recognition by schools and colleges of the educational value of the use of clay.

MARY G. SHEERER, *Chairman*, Art Division.

Metal Enamel Industry

1—Development of wet process enameling of cast iron both over ground coat and as single coat enamels.

2—Improvement in types of furnaces in all branches of the enamel industry.

3—Extension of the uses of enamels both for utility and decorative purposes.

R. R. DANIELSON, *Chairman*, Enamel Division.

Glass Industry

1—Introduction of scientific chemical and physical control and research.

2—Improved devices in the application of fuels for gas producers, tank furnaces and muffle leers.

3—Development of machines to replace hand labor in glassware manufacture.

G. E. BARTON, *Chairman*, Glass Division.

Heavy Clay Industry

1—Improvement in quality and saving in fuel due to the publication of "Effect of Heat on Clay."

2—Development and utilization of fire-proofing.

3—Recognition of the heavy clay industry as a technical industry comparable to the manufacture of steel, etc.

FRANCIS T. OWENS, *Chairman*, Heavy Clay Products Division.

Refractory Industry

1—Development of silica refractories making possible the modern by-product coke oven, open hearth furnace, electric furnace, etc.

2—Development of artificial super-refractories as silicon-carbide and fused alumina.

3—Scientific control applied to refractory manufacture.

FRED A. HARVEY, *Chairman*, Refractory Division.

White Ware Industry

1—Introduction of scientific methods of measurements and reasoning.

2—Increased knowledge and control of pyrochemical and pyrophysical phenomena.

3—Knowledge of the mineral structure of bodies and of the properties and functions of the mineral constituents produced during firing.

F. H. RIDDLE, *Chairman*, White Ware Division.

ACTIVITIES OF THE SOCIETY

The 1925 Annual Meeting

The 1925 Annual Meeting is now history. By unanimous opinion of those attending it was a great success. Cordiality, earnestness, and large expectations for the future characterized the frame of mind of each delegate. Although they were convened three miles distant from the hotels, the sessions started promptly at 10 A.M. and at 2 P.M. with good attendance.

The registration totaled over 900. Subtracting duplicates, ladies, and students the roster shows 857 attending. The banquet was attended by 532. The exhibits were larger and more extensive than at any previous meeting of the SOCIETY.

Gratifying are the statistics of this 1925 Annual Meeting but of more importance are two outstanding inspirational facts. (1) The past four annual meetings have reflected increasingly the soundness of the principle of decentralized activities and responsibilities under the activating influence of a central office. To hold meetings of seven Divisions simultaneously, each arranged and managed by its own officers, the whole being harmonious in every respect, is a realization of an idea which many had thought wholly impractical. This 1925 Annual Meeting should be recognized as fully justifying continued collaboration of the several industrial groups on this program. (2) The second pleasing fact regarding this Meeting is found in the following analysis of the program participants:

Authors from	Number	Per cent
Ceramic Schools	22	13.4
Bureaus	21	12.8
Institutes, Associations and Users	16	9.8
Industrial	87	53.0
	164	100.00

In the early years the bulk of the program was furnished by the schools and the bureaus. That more than 50% of the program consisted this year (as did the 1924 program) of contributions from men employed in industrial plants is worthy of careful deductive consideration. It reveals a situation that is very promising for the future of ceramics on this continent.

Columbus hotels proved adequate both in capacity and cordiality. The possibility of successfully holding meetings away from the hotels was proven.

Exhibits

The Ohio Ceramic Industries Association collaborated with the Ohio Archaeological and Historical Society in an exhibit of the ceramic wares produced in Ohio. Though not complete, this exhibit was excellent. A few views of it are here shown. The following firms exhibited:

The American Bottle Co., Toledo, Ohio; American Encaustic Tiling Co., Zanesville, Ohio; The Atlas China Co., Niles, Ohio; The Bellaire Enamel Co., Bellaire, Ohio; The Cambridge Glass Co., Cambridge, Ohio; Cambridge Sanitary Mfg. Co., Cambridge, Ohio; The Colonial Insulator Co., Akron, Ohio; Columbus Clay Mfg. Co., Black Lick, Ohio; The Crooksville China Co., Crooksville, Ohio; The Estate Stove Co., Hamilton, Ohio; The Evans Pipe Co., Uhrichsville, Ohio; The Federal Clay Products Co., Mineral City, Ohio; The Federal Glass Co., Columbus, Ohio; Fraunfelter China Co., Zanesville, Ohio; E. Houghton & Co., Dalton, Ohio; The Iron Clay Co., Columbus, Ohio; Maurice A. Knight Co., Akron, Ohio; The Massillon Refractories Co., Massillon, Ohio; The Mogadore Insulator Co., Mogadore, Ohio; Montgomery Porcelain Products Co., Franklin, Ohio; The Ohio Clay Co., Cleveland, Ohio; Ohio Insulator Co., Barberton, Ohio; The Pfaudler Co., Elyria, Ohio; The Pope-Gosser China Co., Coshocton, Ohio; The Pyro Clay Products Co., Oak Hill, Ohio; Rookwood Pottery Co., Cincinnati,

Ohio; Rush Creek Clay Co., Junction City, Ohio; The Sebring Pottery Co., Sebring, Ohio; A. A. Simonds-Dayton Co., Dayton, Ohio; The Standard Pyrometric Cone Co., Columbus, Ohio; The Stark Brick Co., Canton, Ohio; The Straitsville Impervious Brick Co., New Straitsville, Ohio; Vitrolite Co., Parkersburg, W. Va., S. A. Weller Pottery Co., Zanesville, Ohio.

The Von Gerichten Art Glass Co., Columbus, Ohio.

The equipment and materials concerns exhibiting in Lord Hall were:

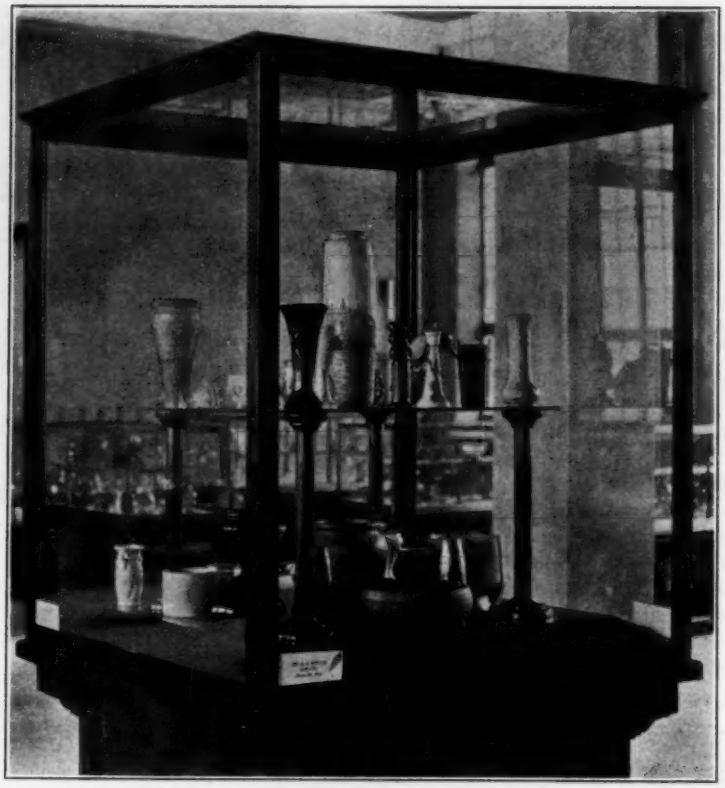
Armstrong Cork & Insulation Co., American Rolling Mill Co., Brown Instrument Co., Buckeye Clay Pot Co., Crescent Brick Co., Celite Products Co., Carrier Engineering Co., Eagle-Picher Lead Co., Chas. Engelhard, Inc., Genesee Feldspar Co., Heath Unit Tile Co., O. Hommel Co., Kauffman-Lattimer Co., Leeds & Northrup Co., Macleod Company, Massillon Refractories Co., Manufacturers Equipment Co., Newark Wire Cloth Co., Ohio Hydrate & Supply Co., Orville Simpson Co., Potters Supply Co., Russell Engineering Co., Roessler & Hasslacher Chem. Co., W. W. Stanley Co., Thwing Instrument Co., W. S. Tyler Co., Titanium Alloy Mfg. Co., Wilson-Maeulen Co., The Wahl Co., Crescent Refractories Co., Hy-grade Manganese Co., McLanahan-Watkins Co.

These exhibits are conducted at actual operating cost to the exhibitor. They are not commercial enterprises. They are presented because of their educational value.

Rookwood Pottery.

The following schools were represented in school exhibits held in Lord Hall. It is regrettable that a view of the North Dakota School exhibit is the only one available to show the character of these school exhibits.

Rutgers College, Georgia Institute of Technology, University of Illinois, Iowa State College, New York State School of Ceramics, Pennsylvania State College, University of North Dakota, Ohio State University, University sity of Washington, University of Saskatchewan, Newcomb School of Art, Winnipeg School of Pottery, Lewis Institute.



S. A. Weller Pottery Co., Zanesville, Ohio.

General View of Exhibit.

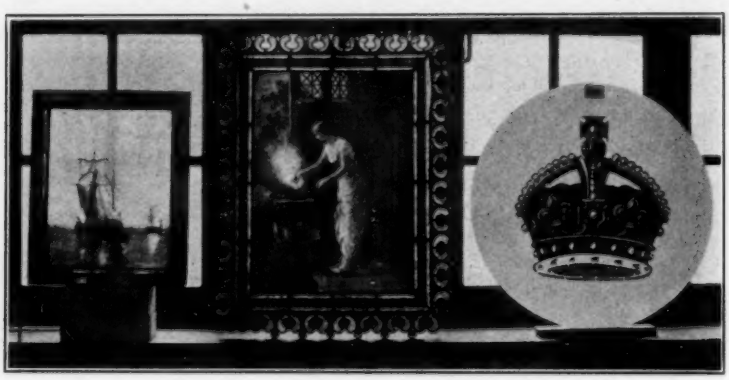
The Federal Glass Co., Columbus, Ohio.

The Sebring Pottery Co., Sebring, Ohio.

One Corner of the Brick Exhibit.

The Pope Gosser China Co., Coshocton, Ohio.

The Cambridge Glass Co., Cambridge Ohio.



The Von Gerichten Art Glass Co., Columbus, Ohio.

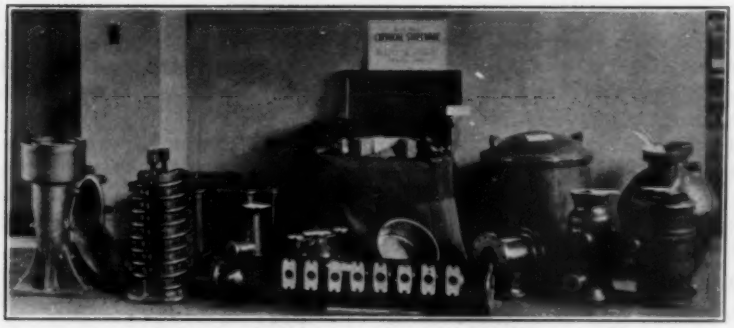
The Fraunfelter China Co., Zanesville, Ohio.

The Fraunfelter China Co., Zanesville, Ohio.

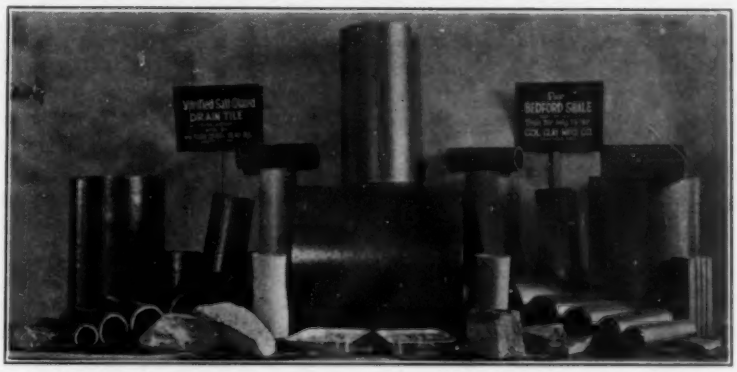
The Federal Glass Co., Columbus, Ohio.

American Encaustic Tiling Co., Zanesville, Ohio.

Exhibit of University of North Dakota.



Maurice A. Knight, Akron, Ohio.



Rush Creek Clay Co., Junction City, Ohio.
Columbus Clay Mfg. Co., Black Lick, Ohio.

The Anniversary Lesson

The 1925 Annual Meeting was in celebration of the Thirtieth Anniversary of the founding of the world's first collegiate ceramic school. The Ohio State University had invited all ceramic groups to meet on its campus for this purpose and a very informing program was given. The importance of collegiate training in ceramics as shown by the results realized was very strongly set forth. The only phase lacking was a conference on how the universities can best meet the present-day requirements.

Dr. Tillotson gave several important recommendations and it should be apparent that with the facts and inventions made and recorded during the past thirty years the college curriculum possibly should be revised.

That the curriculum devised by Prof. Orton was the very best for those early years there can be no questioning. It was sound in every respect and met the most urgent needs. What seems to be needed today is the directing of our studies more on ceramic products and means of their production to standards, and less on the materials and mixtures.

The school graduates whose instruction ranged from the fundamentals to a finished product would have a vision and a direction in their thinking that is very much needed; indeed this is what makes the shop trained student a superior factory director. Natu-

rally, in such a curriculum of four years' duration equal emphasis cannot be given to all things with which a factory operating ceramist must be familiar hence the present day curriculum should take into consideration the large fund of information which has been written into our literature during the past thirty years and which is available to him who is trained to read and which need not be repeated.

There can be no knowing of the essentials of a satisfactory product without studying the product and the essentials to its production. This should have a large place in our present day school curriculum. An analysis of the Division programs at this Meeting and of the problems now being investigated by the Bureaus and Mellon Institute would reveal the things which should be emphasized in a ceramic school curriculum.

Greetings from England The following congratulatory note from J. W. Mellor, of the Ceramic Society, England, was received during the meeting:

"I beg to take the opportunity of sending our hearty congratulations to you on the celebration of the Thirtieth Anniversary of the founding of your school of ceramics. The valuable work which has been done there in the past under Prof. Orton has won for it a proud place in the evolution of this industry as an art and as a science."

Our Next Meetings (1) The Summer Meeting will be in Canada probably early in July. (2) Our Fall Meeting will be in New York City in connection with the Chemical Exposition. (3) Our 1926 Annual Meeting will be in Atlanta, Ga., early in February.

Atlanta is a night's ride from St. Louis, Chicago, Detroit, Buffalo, and Pit sburgh. It is directly south from Columbus. It is not as far off the geographic center of the ceramic industries as is New York City. Its location and especially the ceramic things they have to show and the cordiality of the invitations extended makes the 1926 Annual Meeting in Atlanta very attractive.

1925-26 Program The Board of Trustees provided for additional editorial assistance to allow the General Secretary more time to work with the committees. The standing committees are planning more actively this year. A special half-day at the next meeting will be devoted to committee assemblies and reports.

A more thorough program of collaboration with other societies and associations is expected this year and especially with the ceramic trade associations. President Landrum dwelt upon this in his presidential address and his recommendations will be followed.

The programs of all of the Divisions suffered from a surfeit of papers and discussions. This gave rise to several recommendations: (1) Closer adherence to the rules covering time limits and reparticipation in the discussion; (2) preprinting of the papers and presenting of them at the meeting only in abstract; (3) providing for technical sessions at the midyear meetings; (4) creating additional Divisions of (*a*) Ceramic Science, (*b*) Fuels and Furnaces and (*c*) Equipment and Materials. Time should be provided by each of the Divisions for committee reports and dinner meetings. These recommendations will be considered and a workable policy evolved by the Division officers.

The 1925-26 Budget The committee recommends the following budget for 1925–26:

Journal		$16,000.00
Reprints		1,000.00
Salaries:		
Secretary	$5000.00	
Asst. Secy	1800.00	
Asst. Editor	2000.00	
Assistant	1200.00	
Extra	1300.00	11,300.00

Traveling	1,000.00
Office Expense	4,000.00
Meeting	1,500.00
Committees	300.00
Divisions	1,000.00
Miscellaneous	500.00
Contingent Fund for President	800.00
Editorial Assistance	2,500.00
	$39,900.00

(Signed) A. F. GREAVES-WALKER, *Chairman.*
Passed by Board of Trustees February 19, 1925.

THE 1925 ANNUAL MEETING PROCLAIMED A HUGE SUCCESS

The General Secretary of the SOCIETY would not be human if he were not gratified in the extreme with the many, many complimentary words spoken and written concerning the 1925 Annual Meeting. It was a huge success from standpoint of attendance, management, entertainment and (the most gratifying) in quality of papers and discussions presented. Quoting a letter from a non-member who is high in the councils of three scientific associations and a constant program contributor and attendant of several: "I never attended a better meeting of any organization. You are particularly to be congratulated upon the practical experience of those who joined in discussions as well as the highly developed scientific nature of the papers and discussions. Such a combination does not exist in any other society which I know."

This and many similar congratulatory comments cannot but thrill and encourage, but as the General Secretary I have a confession. I am not and cannot be made to feel responsible for the success of this Meeting notwithstanding the immense pride I feel because of it. To the officers and committeemen of the Divisions belongs every bit of the credit for the technical programs and the conducting of the Division meetings. They solicited the papers and arranged the programs. To Professor Arthur S. Watts belongs the entire credit for the exercises in celebration of the 30th Anniversary of the founding of collegiate education in America. To Professor James T. Robson and his pupils belongs the entire credit for the many conveniences and the inter-Division service during the meetings. To Professor Carl B. Harrop and his staff belongs the credit for that universally enjoyed banquet. To Mrs. A. S. Watts, Mrs. S. R. Scholes, Mrs. R. C. Purdy, Mrs. G. A. Bole and to the wives of the other local ceramists is due the credit for what many of the ladies thought was the most attractive ladies' special entertainments. The ceramic manufacturers of Ohio deserve all of the credit for the cash and the exhibits which added so much to the "pleasure of all." Dr. William C. Mills, Director of the Ohio Archaeological and Historical Society worked untiringly and with success in interest of the exhibit of ceramic products of Ohio and Mr. L. E. Geyer for the splendid exhibit of ceramic equipment and materials. President W. O. Thompson and Dean E. A. Hitchcock of the University gave much personal time and considerable influence in securing many things which added to the comfort and pleasure of their 975 guests. And finally, but not least, much credit is due to the local committees and persons who carried out their assigned tasks making it possible for every attendant to secure comfortable hotel and other accommodations with the least possible worry and confusion.

The credit for the success of the 1925 Annual Meeting is due to a well-rounded and 100% working organization of Division officers and committees, and enthusiastic and

closely collaborating local men and women. The General Secretary merely served in capacity of a switchboard operator or traffic cop to whom was brought only those duties and responsibilities of an information bureau clerk.

NEW MEMBERS RECEIVED DURING ANNUAL MEETING

PERSONAL

J. Guild Carter, 567 E. State St., Trenton, N. J. Salesman, Genesee Feldspar Co.
J. Y. Cheney, Box 1017, Orlando, Fla. General Manager, Orlando Potteries.
F. R. Colvin, Monongahela, Pa. President, Bessemer Brick Co.
William T. Cristman, 844 Hoben St., McKees Rocks, Pa. Superintendent, Federal Enameling & Stamping Co.
Robert E. Elliot, Box 609, St. Johns, Que., Canada. Manager, Canadian Potteries, Ltd.
E. Olney Herman, Box 54, Momence, Ill. Manager, Tiffany Enameled Brick Co.
Thomas Kennedy, 58 High Park Blvd., Toronto, Canada. General Manager, Dominion Sewer Pipe & Clay Co.
Frank A. King, Vitrolite Co., Parkersburg, W. Va. Superintendent.
Levi S. Longenecker, 409 Bessemer Bldg., Pittsburgh, Pa. District Representative, Vitrefrax Co., Refractory Engineer.
George L. McCreery, 523 N. 6th St., Barberton, Ohio. Chemist, Ohio Insulator Co.
Frank R. Mahurin, Box 123, Bessemer, Pa. Superintendent, Plant No. 2, Metropolitan Paving Brick Co.
A. R. Mallon, Wayne Ave., McKees Rocks, Pa. Enameler, Federal Enameling & Stamping Co.
R. M. Onan, 111 N. Canal St., Chicago, Ill.
J. Clair Peck, Ridgway, Pa. Manager, Ridgway Brick Co.
A. Bryce Redman, Millville, N. J. Manager, T. C. Wheaton Co.
Thomas S. Rogers, 120 W. Kinzie St., Chicago, Ill. Manager, Ceramic Department, Innis Speiden & Co.
David L. Rouleau, 24 Miller St., Mt. Clemens, Mich. General Superintendent, Mt. Clemens Pottery Co.
H. R. Straight, Adel, Iowa. President, Adel Clay Products Co.
T. Dwight Tefft, Darlington, Pa. Manager, Darlington Clay Products Co.
Robert A. Thompson, 409 Philip Ave., Detroit, Mich. Enameler, Porcelain Enamel & Mfg. Co.
John Winkler, 11000 Woodstock Ave., Cleveland, Ohio. Enameler, Cleveland Enameling & Mfg. Co.

CORPORATIONS

The Delaware Clay Mfg. Co., Delaware, Ohio. L. L. Denison, President.
Georgia White Brick Co., Gordon, Ga. W. F. Demuth.
Kentucky Construction & Improvement Co., Mayfield, Ky. R. W. Greene, Manager.
Surface Combustion Co., 366–68 Gerard Ave., Bronx, New York City, F. M. Burt.

Membership Workers' Record

	Personal		Personal	Corporations
H. C. Arnold	1	L. W. Manion	2	
R. F. Brenner	1	A. W. Whitford	1	
H. S. McMillan	1	Office	15	4
			—	—
			21	4

NEW MEMBERS RECEIVED FROM JANUARY 15 TO FEBRUARY 15

PERSONAL

Thomas M. Arnold, 59 E. Frambes Ave., Columbus, Ohio. Student.

Donald W. Boddy, Tennessee Furniture Corp., Chattanooga, Tenn. Superintendent, Porcelain Plant.

Horace N. Clark, Johns-Manville Co., Manville, N. J.

John F. Hager, Jr., care of Bruce & Hager, Ashland, Ky.

Henry W. Harrington, 222 Rand Ave., Lexington, Ky. Superintendent, Bybee Pottery Co.

G. R. Hostetler, 2505—11th St., N. W., Canton, Ohio. Secretary and Treasurer, Castalia Lime & Marl Co.

W. J. Hoven, American Stove Co., 4101 Hough Ave., Cleveland, Ohio.

Hilding Johnson, Celite Products Co., Lompoc, Calif. Ceramic chemist.

Robert H. Louden, Anderson, Indiana. Ceramic Engineer, National Tile Co.

William Marshall, Vern Dale—Bushbury Road, Heath Town, Wolverhampton, England.

Richard H. Martin, 51 Nelson Place, Worcester, Mass. Ceramist, Norton Co.

John F. McMahon, 109 E. Water St., Lock Haven, Pa. Ceramic Engineer, Queens Run Refractories Co.

Edward Norman, Vitrefrax Co., 51st & Pacific Blvd., Vernon, Calif. Superintendent.

Frederick H. Opper, Box 348, Savannah, Ga. President, Savannah Kaolin Co. and Gordon Kaolin Co.

Wilber L. Orme, The Cambridge Glass Co., Cambridge, Ohio. Vice-President.

Walter Schulz, National Enameling & Stamping Co., Granite City, Ill. Ceramic chemist.

P. G. Strassmann, Silamit-Werke, Crefeld-Linn, Germany. President, Silamit-Werke.

A. H. Sullivan, 389 Arcade Bldg., St. Louis, Mo.

Victor N. Yingling, 58 King Ave., Columbus, Ohio. Ceramic Engineering Co.

CORPORATION

Sanitary Scale Co., Belvidere, Ill.

Membership Workers' Record

	Personal		Personal	Corporations
M. F. Beecher	1	W. A. Mudge	1	
Chas. F. Binns	1	W. D. Richardson	1	
K. H. Endell	1	R. R. Shively	1	
Robert F. Ferguson	1	H. F. Staley	1	
H. J. Knollman	1	Office	10	1
			19	1

LOCAL SECTION MEETINGS

The Baltimore-Washington Section[1]

The third meeting of the 1924–25 season of the Baltimore-Washington Section was thoroughly enjoyed by the largest crowd which has yet attended one of the local meetings. The meeting was held in the rooms of the Old Colony Club, Hotel Emerson, Baltimore, Md., at 7.00 P.M. Saturday, February 7, 1925.

[1] R. R. Fusselbaugh, Secretary.

We were addressed by Henry P. Rodgers of Rodgers and Reitz on "Thermo-Electric Pyrometry and Its Applications." Mr. Rodgers covered his subject in a thoroughly technical manner and his points were so well taken care of that very little discussion followed.

Next in order was a paper by Charles C. Krause of the Consolidated Gas & Electric Light & Power Co. on "The Use of Gas in Industry." We were given a look into the innumerable uses of gas with special emphasis upon the use of gas in enameling. Mr. Krause invited discussion at various times when he felt that those present would be especially interested. Needless to say he was set upon from all sides, but came up with his colors still flying.

The section expressed their appreciation of the knowledge placed before them by these two experts, and it was the consensus of opinion that, in view of the fact there seemed to be no limit to the use of pyrometers and gas, if the next world for some of them should be a hot one, it would be heated by gas and kept under control by recording automatic pyrometers.

It was then decided to hold our next election at the close of the next meeting, which will be held in Washington at 7.00 P.M., Saturday, April 4, 1925. This will allow the new officers time to prepare for their term.

Anyone interested in ceramics who should be in the vicinity of Baltimore or Washington at the time of our next meeting is cordially invited to attend. Communicate with the Secretary.

The Chicago Section[1]

A meeting of the Chicago Section of the AMERICAN CERAMIC SOCIETY was held in the Morrison Hotel on Saturday, January 10, 1925.

After lunch the meeting was called to order by Chairman H. C. Beasley. The Chairman of the Nominating Committee, Leo A. Behrendt, recommended the following members for officers during the year 1925.

President, W. V. Knowles
Vice President, Wm. J. Benner
Secretary-Treasurer, Bruce F. Wagner
Chairman Program Committee, A. F. Gorton
Councillor, C. W. Parmelee.

The above members were unanimously elected.

The first thing on the program was a general discussion of the Columbus Meeting and plans were made for the Chicago Section to go to Columbus on a special car. The discussion turned to ways and means of increasing interest and having more frequent meetings of the local chapter.

The following papers were presented:

"An Oil Fired Smelting Furnace," by Robert MacDougall.

"A Bonus System for Foremen," by H. C. Beasley.

There were forty-one members present.

St. Louis Section Meeting[2]

A meeting of the St. Louis Section of the AMERICAN CERAMIC SOCIETY was held at the City Club on Tuesday, February 3. Twenty-two members were in attendance.

[1] Bruce F. Wagner, Secretary.

[2] L. C. Hewitt, Secretary.

H. W. Brewer, President of the Wallace Pencil Company, presented a discussion on "The Manufacture of Pencils," which was the chief feature of the program.

The following officers were chosen for the coming year:

Chairman, F. E. Bausch
Secretary and Treasurer, L. C. Hewitt
Councillor, C. W. Berry.

The Pacific-Northwest Section[1]

Fifty-five were present at the annual technical meeting of the Pacific-Northwest Clayworkers' Association on the afternoon of Jan. 17 and discussed the following program: A Study of the Puget Sound Glacial Clays and Shales, by T. O. Smith, Department of Ceramic Engineering, University of Washington; Scumming and Efflorescence of Brick Work, by M. E. Reynolds, Department of Ceramic Engineering, University of Washington; The Marketing of Clay Products, by Prof. W. A. Russell, Department of Business Administration, University of Washington; The Insulation of Ceramic Kilns, by E. J. Bartells, of the E. J. Bartells Company, Seattle; Spalling Tests of Local Fire Clay Brick, by Hewitt Wilson, Department of Ceramic Engineering, University of Washington.

Officers elected for 1925 were: Hewitt Wilson, president; Henry Hoffmann, Lake Union Brick and Fireproofing Co. of Seattle, vice-president; Samuel Geijsbeek, secretary and treasurer; E. E. Saunders, American Fire Brick Co. of Spokane, trustee representing refractories; George MacFarlane, Seattle Brick and Tile Co., trustee representing brick and tile; V. E. Piollet, Washington Brick Lime and Sewer Pipe Co., Spokane, trustee representing sewer pipe; A. L. Bennett, Northern Clay Co., Auburn, Wn., trustee representing terra cotta.

The afternoon session at the new Chamber of Commerce Building, Seattle, was followed by a banquet at the new Olympic Hotel. Over 70 ladies and men were present at this meeting. The entertainment consisted of songs by Miss Louise Lohse, daughter of a prominent brick manufacturer in Seattle, songs by the University of Washington quartette; some very clever sleight of hand tricks of misdirection and talks by H. R. Kreitzer, president of the Brick Manufacturers' Association; Mr. F. T. Houlahan, president of the Clayworkers' Association, Dean Milnor Roberts, School of Mines; Dr. Henry Suzzallo, University of Washington and Hewitt Wilson, toastmasters.

The recorded attendance is as follows: F. T. Houlahan, Seattle; A. H. Wethey, Jr., Portland; W. E. Wilson, Salem, Ore.; John H. Corbett, Yakima, Wn.; Willard P. Palin, Tacoma; A. L. Bennett, Auburn, Wn.; E. F. Goodner, Spokane; H. B. McMillen, Seattle; Olaf Olsen, Des Moines, Wn.; L. K. Miller, Seattle; Jess Cooper, Seattle; N. W. L. Brown, Sumas, Wn.; Foster Hidden, Vancouver, Wn.; E. G. Krebs, Tillamook, Ore.; C. A. Houlahan, Seattle; Geo. O. Kribs, Seattle; C. M. Brasfield, Seattle; Willis E. Clark, Seattle; Geo. C. Feller, Longview, Wn.; C. E. Curtis, Seattle; H. Hoffmann, Seattle; D. M. Baird, Chicago; Arthur Houlahan, Seattle; E. K. McQuarrie, Seattle; H. R. Kreitzer, Portland; M. B. Reilly, Portland; V. E. Piollet, Spokane; J. B. Stirrat, Seattle; J. O. Greenway, Spokane; Frank Lohse, Seattle; J. W. Knapp, Mt. Vernon; D. Shaffer, Everett; Burton Shaffer, Mt. Vernon; Blake R. Thompson, Mt. Vernon; E. J. Hutmaker, Seattle; C. S. Engelbrecht, Seattle; T. O. Smith, Seattle; M. E. Reynolds, Seattle; T. E. Nicholson, Seattle; W. J. Howard, Seattle; H. H. Bartells, Bellingham; L. Longiton, Granger, Wn.; E. G. Wulff, Renton, Wn.; Geo. Adderson, Renton;

[1] Combined meeting of the Pacific-Northwest Clayworkers' and Brick Manufacturers' Associations. (Local section of AMERICAN CERAMIC SOCIETY.)

W. E. Lemley, Taylor, Wn.; R. H. Clinton, Seattle; W. A. Steinhauser, Seattle; E. J. Bartells, Seattle; R. A. Swain, Seattle; Hewitt Wilson, Seattle; Samuel Geijsbeek, Seattle; W. A. Russell, Seattle.

The Pittsburgh Section

Thirty-nine members of the Pittsburgh Section of the AMERICAN CERAMIC SOCIETY journeyed to East Liverpool, Ohio, on January 16, where they inspected Plant No. 6 of the Homer-Laughlin China Co. at Newell, W. Va., Plant No. 1 of the Hall China Co. and the Lisbon, Ohio, plant of the R. Thomas and Sons Co.

The members with their president, J. W. Cruikshank, arrived in East Liverpool on an early train and were taken at once to the Newell plant. Special interest was taken in the tunnel kilns which are being operated there.

REPORT OF COMMITTEE ON DATA

Data Which Has Been Compiled

Tensile Strength of Some Metals at Ordinary Temperatures
Mean Specific Heats of Gases
Cubic Expansion of Gases, per Degree Centigrade
Coefficient of Linear Expansion per Degree Centigrade
Weights of Rock and Sand
Coefficients of Linear Expansion per Degree Centigrade
Latent Heats of Fusion—Compounds—Silicates
Specific Gravities and Unit Weights of Solids and Liquids
Batteries, E. m. f. of Standard Cells
Hydrometer Conversion Factors
Work and Energy
    Weight, Force or Pressure, Combined with Areas
    Table of Equiv. Values for Power Expressed in Various English and Metric Units
C. G. S. Units
Conversion Tables, Cubic Measure
Conversion Weight—English
Conversion Table—Weight
Units of Heat
Standard Thermometric Points
Conversion Table, Linear Measure
Conversion Table, Square Measure
Comparison of the Properties of Fused Silica and Hard Porcelain
Specific Heat of Gases (Calories per gram of gas at t°C)
Table of Mean Specific Heats (Calories per gram of gas)
Comparative Composition of Different Fuels (Moisture content when new)
Oxygen and Air Required for Perfect Combustion
Theoretical Maximum Combustion Temperatures
Limits Fuel Analysis—United States
Typical Gas Analyses
Baumé Gravity and Corresponding Specific Gravities, Weights per Gallon and Calorific Power of Oil

Heat of Formation of Aluminates
Reduction Temperatures of Some Refractory Oxides
Decomposition of Carbonates
Decomposition of Sulphides
Heat of Formation of Silicates
Total Heat Contained in Certain Silicates When Melted

Table of Mean Specific Heats—Calories per Gram of Gas
Mean Specific Heats of Gases
Specific Heats of Gases
Specific Heats of the Oxides

Latent Heats of Evaporation
Specific Heats of Aluminates, Titanates, Etc.
Standard Sizes of Clay Products—Brick; Load Bearing Tile; Paving Brick
Properties of Some Selected Domestic Bond Clays

Enamels

Tables of Expansion Values for Compounds and Some Materials
Method of the Calculation of the Coeff. of Expansion of Enamels and Glasses
Table of Compounds and Oxides Used in Enamels with Atomic and Molecular Weights
Method of Calc. of Melted Comp. from Batch Weights
Method of Calc. of Molecular Formulas from Batch Weights
Twelve Typical Enamel Formulas Which Will be Sent You as Soon as Copies Can Be Made. Sheet and Cast Metal Included
Table of Standard Gauges for Sheet Metal
Weight of Enamel per Sq. Ft. of Sheet Steel
List of Heat Resisting Alloys for Burning Tools
List of Acid Resisting Alloys for Pickling Baskets
Suggestions have been made that the following material be covered:
Specific Gravity and Percentage Composition of Acids Used for Pickling; Also a List of Pickling Compounds
Tabulation of the Various Constituents Used in Enamels and Their Effect upon the Physical Properties of the Enamels
Common Faults of Enamels and Their Corrections
Range of Composition of Sheet Iron and Steel and Cast Iron Used for Enameling

Glass

Raw Materials and Their Properties
Coloring Materials

Heavy Clay Products

Mr. Schurecht reports that the collection of data on heavy clay products, including the following—brick of various kinds; strength of brick in masonry; strength of mortar and masonry; salt glazed pipe; drain tile; hollow building tile—is about 90% completed.

Further, that information relating to heavy clay products with respect to flow sheets showing stages of manufacture of several products; (2) short paragraph showing essential differences between stiff mud, soft mud and dry press process; (3) ditto describing properties of materials suited to these several processes; (4) data relating to the ordi-

narily used processes—covering types of apparatus (all materials), capacities, costs, etc., relating to (*a*) blasting; (*b*) excavating; (*c*) loading; (*d*) hauling; (*e*) crushing, grinding; (*f*) screening; (*g*) mixing or pugging; (*h*) shaping—is about 20% completed.

Refractories

See following report:
Members of Committee: L. J. Trostel (*Chairman*); J. T. Robson and J. B. Shaw.

Plan of Work

The ultimate idea is to develop data along the outline suggested by Professor Parmelee in his general letter of Oct. 1, 1923 to the Data Committees of the various divisions of the SOCIETY. The general lines of attack were to be: I, Raw Materials. II, Processes. III, Finished Products.

The program of our Committee for this year has been to try and cover only points I and III, since the points to be investigated are similar. These points include:

1. Definitions
2. Specifications
3. Sources of Supply
4. Analyses
5. Formulas
6. Methods of Testing
7. References in the Literature

This first year's program was divided into three phases, each to be investigated by a member of the committee as follows: (*a*) Acid Refractories, Prof. Shaw; (*b*) Basic Refractories, Prof. Robson; (*c*) Neutral Refractories, Mr. Trostel. The committee will cover point II of the above outline in similar fashion working up a flow sheet of the various processes concerned in refractories manufacture and attempt to collect all pertinent data relating to the processes and product.

Outline of Results

1. *Definitions.* This matter was taken up with Dr. Harvey, Chairman of the Division, and it was decided to leave the actual formulation of the definitions to the Society's Committee on Nomenclature which has been working on the topic for several years. We will then include any definitions of refractories arrived at in our final report. The Committee will also draw upon the definitions arrived at by the A. S. T. M.

2. *Specifications.* Specifications covering the purchase of refractories and refractory materials are existent with probably a dozen large consumers at present as well as the various government departments, such as the Navy, Fleet Corporation and others. A list of such consumers has been compiled and one of the members of the committee will attempt to collect such specifications. The published specifications of the Bureau of Standards and the A. S. T. M. will also be included.

3. *Sources of Supply.* The Society's Committee on Geological Survey is covering this topic for all materials and our committee will keep in touch with them.

4. *Analyses and Formula.* O. A. Hougen of the Chemical Engineering Department of the University of Wisconsin has published a very extensive and comprehensive table in *Chemical and Metallurgical Engineering*, May 12, 1924, covering practically the entire refractory field. This table lists the formula (composition), resistance to basic and acid fluxes, resistance to molten metals, softening and fusion point, deformation under load and coefficient of expansion. Complete references to the literature accompany the table. This, we hope to be permitted to incorporate in the handbook eventually.

5. *Methods of Testing.* The only tests we will be concerned with are those already standard. This will include those suggested by the SOCIETY and the A.S.T.M. and will cover both chemical and physical tests.

6. *References in the Literature.* This is particularly well taken care of in the very excellent bibliographies in existence on magnesite, silica and the one shortly to be issued on clay. One of the members of the committee has started a bibliography covering chrome which will round out the typical refractories.

(Signed) LOUIS J. TROSTEL, *Chairman*

Pottery

Owing to the inability of Mr. Treischel to continue on the committee, Edward Schramm was appointed to fill his place, but owing to some misunderstanding he was not notified until subsequent to January of this year.

Mr. Schramm has been requested to compile data relating to pottery and porcelain, excepting such as may be included under the head of sanitary ware and electrical porcelain.

Mr. Klinefelter has been requested to furnish information regarding the manufacture of types of sanitary ware which might properly be included under the type of white ware, namely, vitreous and earthenware.

Mr. Twells has been requested to compile information relating to the manufacture and properties of electrical porcelain.

Terra Cotta

Mr. Klinefelter has been requested to compile information relating to architectural terra cotta. No reply has been received from him regarding this matter.

Glass

Reference has already been made to the information at hand relating to the manufacture of glass. In addition, A. E. Williams has been requested to furnish the following information:

Definitions and simple classifications of principal types of glass

Ceramic formulas and batch weights of more important types

Graph showing limits of compositions of more important sorts of glasses

Statement regarding the use of Tscheuschmer's formula.

G. B. McCauley, Corning Glass Works, has been requested to furnish information relating to coefficient of thermal expansion: strength, plasticity, etc.

It is recommended that R. K. Hursh be invited to assist in the compilation of data relating to drying and firing.

C. W. PARMELEE, *Chairman*

Supplementary data received from the Chairman of the Enamel Division states that the following tables are now being compiled:

1. A tabulation of various raw materials used in enamels and their effects
2. Common faults of (causes of failure) enamels and their correction
3. Cleaning compounds for sheet iron and steel
4. Tables of specific gravity of acids used for pickling
5. Ranges of compositions of iron and steel for enameling.

R. J. Montgomery of the Sub-committee on Glass has sent data relating to decolorizers, clarifiers, opacifiers, physical properties of glass, types and specific gravities of optical glass of various sorts, and hardness of glass.

NOTES AND NEWS

U. S. GOVERNMENT MASTER SPECIFICATIONS FOR FIRE CLAY BRICK[1]

This specification was officially promulgated by the Federal Specifications Board on January 22, 1925, for the use of the Departments and Independent Establishments of the Government in the purchase of fire clay brick.

The latest date on which the technical and inspection requirements of this specification shall become mandatory for all Departments and Independent Establishments of the Government, is April 22, 1925. They may be put into effect, however, at any earlier date, after promulgation.

Classes

I. Fire clay brick shall be of the following classes: SH 75, H 75, H 57, M 73, H 25, M 7.

For derivation of the class nomenclature used see Section VII of this specification

Material and Workmanship

II. The material covered by this specification is a brick of standard or special shape composed of heat-resistant clay or clays and which has been fired to produce the desired strength and structure. The brick shall be compact, of homogeneous structure, free from checks, cracks, voids or soft centers. All corners shall be sufficiently solid and strong to prevent excessive crumbling or chipping when handled.

General Requirements

III. All brick of the standard 9-inch series shall not vary from specified dimensions more than $^1/_8$" in width and thickness, and $^3/_{16}$" in length. For special shapes no dimension specified unless greater variation is allowed by contract, but in no case shall a variation of less than $^1/_8$" be specified and they shall be free from such swells, warps, twists, or distortions as shall prevent ready and accurate laying up with a maximum joint of $^1/_8$".

Detail Requirements

IV.

CLASS SH 75

1. The material shall contain not more than 65% total silica, SiO_2.
2. The softening point shall be not less than that of standard pyrometric cone 31 (approximately 1650°C or 3000°F).
3. The material shall withstand 15 quenchings without failure.
4. When specified the brick shall pass the simulated service test.

CLASS H 75

1. The softening point shall be not less than that of standard pyrometric cone 31 (approximately 1650°C or 3000°F).
2. The material shall withstand 12 quenchings without failure.

CLASS H 57

1. The softening point shall be not less than that of standard pyrometric cone 31 (approximately 1650°C or 3000°F).

[1] Federal Specifications Board Specifications No. 268.

2. The material shall withstand 5 quenchings without failure.
3. The absorption after reheating shall be not less than 6% nor more than 16%.

CLASS M 73

1. The softening point shall be not less than that of standard pyrometric cone 29 (approximately 1610°C or 2930°F).
2. The refractory shall withstand 2 quenchings without failure.

CLASS H 25

1. Siliceous brick shall contain 70% or more total silica, SiO_2.
2. The softening point shall be not less than that of standard pyrometric cone 28 (approximately 1390°C or 2895°F).
3. The material shall withstand 6 quenchings without failure.
4. The deformation under load shall not exceed 3%.

CLASS M 7

1. Siliceous brick shall contain 70%, or more, total silica, SiO_2.
2. The softening point shall be not less than that of standard pyrometric cone 28 (approximately 1590°C or 2895°F).
3. The material shall withstand 3 quenchings without failure.
4. The deformation under load shall not exceed 4%.

Method of Testing

V. 1. The content of total silica shall be determined by analytical methods described under the A. S. T. M. Standard method, Serial Designation C 18–21.

2. The softening point shall be determined according to the A. S. T. M. Standard Method of Test for Softening Point, Serial Designation C 24–20.

3. The quenching test shall be conducted on standard 9-inch straight brick which have been brought uniformly, under no load, to 1400°C (2552°F) in not less than 5 hours and held for 5 hours, and allowed to cool in the kiln and without induced draft to room temperature.

The quenching is conducted in the following manner: the brick is heated by placing in the door of a suitable furnace which is being held at a temperature of 850°C (1562°F). The heated end of the brick should be flush with the inner face of the furnace and the outer end should be exposed to the free circulation of air.

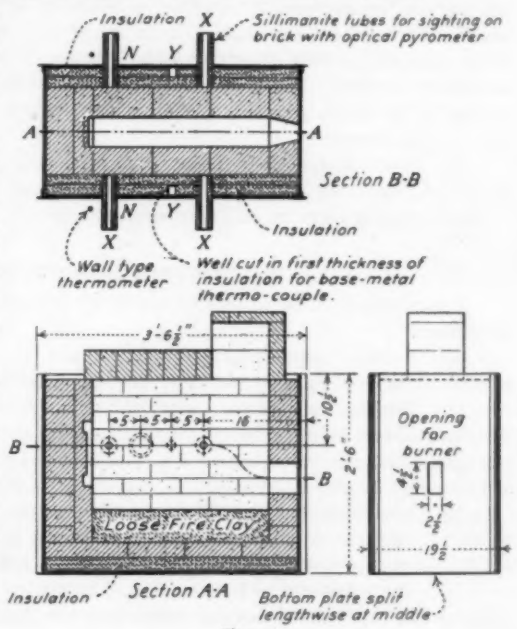


FIG. 1.

At hourly intervals the hot end of the brick is immersed in running water for 3 minutes and to a depth of 4 inches. The brick is then removed, allowed to steam in the air for 5 minutes, and returned to the furnace door. This cycle is repeated until the specimen has failed.

The brick is considered to have failed when the entire plane surface of the heated end has completely spalled away, or when the structure of the brick has become so weakened that the end can be easily removed with the fingers.

The results of any one brand shall be reported as the average of 5 specimens.

4. The absorption shall be determined for brick which have been brought uniformly under no load to 1400°C in not less than 5 hours and held for 5 hours and allowed to cool in the kiln and without induced draft to room temperature.

The test shall be conducted on specimens not less than 100 grams in weight, one specimen to be taken from each of 5 bricks of any one brand and the average result reported.

The per cent absorption shall be determined according to the following formula:

$$\text{Per cent absorption} = \frac{W - D}{D} .100$$

W = weight of specimen after having been boiled in water for 2 hours and allowed to cool in the water.

D = weight of specimen after having been dried to constant weight at 110°C.

5. The load test shall be conducted according to the A. S. T. M. Standard Method of Test for Heavy Duty Fire Clay Refractory Material under Load at High Temperatures, Serial Designation C 16–20.

6. The simulated service tests shall be conducted in the following manner:

(*a*) Tests are conducted in small oil-fired furnaces, the dimensions and method of construction of which are shown on page 145. For comparative purposes, one side wall of the combustion chamber is built up of brick and cement of approved brands and the other side wall of brick and cement of the samples under examination. Both walls are backed uniformly with 3 inches of insulation. An air atomizing fuel oil burner is used. The flame sweeps the length of the furnace, curves upward and returns to the front, then up the stack from which it escapes horizontally toward the rear of the furnace.

(*b*) The test consists of 2 runs, each of 24 hours duration, at furnace temperatures of 1590°C and 1650°C (approximately 2895°F and 3000°F) respectively.

(*c*) During each run the following temperature determinations are made:

Furnace Temperatures

Temperatures of outer face of brickwork of each side wall at the front and rear of furnace.

(*d*) Furnace temperatures are determined at quarter-hourly intervals with an optical pyrometer sighting on flame through front of furnace above burner.

(*e*) Temperatures of the outer face of the brickwork of each side wall are determined at half-hourly intervals, with an optical pyrometer sighting on the brickwork through sillimanite tubes, the ends of which are placed flush with the wall. The tubes are carefully lagged and plugged to prevent radiation losses.

(*f*) A spalling test is conducted at the conclusion of each run by injecting air at room temperature under forced draft into the furnace immediately after shutting off the oil supply to the burner. The injection is continued for 2 hours.

(*g*) The comparative heat insulating properties together with the relative conditions of the side walls determine whether or not the material under test is acceptable for use in service.

7. The combined results of workmanship, chemical analyses, softening point, and absorption and load tests where required, shall be considered as a suitability test, but (at the discretion of the purchaser) the simulative service test may replace all other tests included in the suitability test.

8. Workmanship and softening point determination shall be considered as a control test.

Marking

VI. In each brick shall be molded the trade name, or the name of the manufacturer, or such a mark as will serve to identify the material.

Additional Information

VII. 1. The consignor shall be notified of the rejection of a shipment based on this specification, unless otherwise specified, within 10 days after receipt of a shipment at the point of destination. If the consignor desires a retest, he shall notify the consignee within 5 days of receipt of said notice.

2. The cones referred to in this specification are manufactured by the Orton Standard Pyrometric Cone Co. and are known as the Orton pyrometric cone.

3. The class nomenclature used in Section 1 of this specification is based on the following scheme devised by Committee C-8 on Refractories, of the American Society for Testing Materials:

Temperature: Indicated by prefixing proper letter to number H = High temp. M = Moderate temp. L = Low temp.		Load unimportant			Load moderate			Load important		
		Abrasion unimportant	Abrasion moderate	Abrasion important	Abrasion unimportant	Abrasion moderate	Abrasion important	Abrasion unimportant	Abrasion moderate	Abrasion important
Slag Action Unimportant	Spalling Unimportant	1	2	3	4	5	6	7	8	9
	Spalling Moderate	10	11	12	13	14	15	16	17	18
	Spalling Important	19	20	21	22	23	24	25	26	27
Slag Action Moderate	Spalling Unimportant	28	29	30	31	32	33	34	35	36
	Spalling Moderate	37	38	39	40	41	42	43	44	45
	Spalling Important	46	47	48	49	50	51	52	53	54
Slag Action Important	Spalling Unimportant	55	56	57	58	59	60	61	62	63
	Spalling Moderate	64	65	66	67	68	69	70	71	72
	Spalling Important	73	74	75	76	77	78	79	80	81

NOTE: Class SH 75 (special high temperature) is so designated because it is mean to apply to especially severe boiler practice.

4. Definition of classes.

CLASS SH 75: Brick of this class are intended for use under the most severe conditions of boiler practice, such as marine boilers used by the Navy and in plant installa-

tions designed to operate at an average rating of not less than 175. Material of this class should have high resistance to slagging, spalling and severe temperatures.

In the United States Navy service brick of Class SH 75 are used in oil-fired boilers operated at greater than 500 per cent rating, and where severe vibrations and rapid changes in temperature occur. In this service the brick are secured by anchor bolts.

CLASS H 75: Brick of this class are intended for use under conditions such as are encountered in general boiler practice. For this class, resistance to slagging, spalling and high temperature is important.

CLASS H 57: Brick of this class are intended for use under conditions where resistance to spalling is not of great importance and where resistance to slagging and high temperature is important. In general boiler practice they may be used in the side walls, but, if the refractories used are limited to one brand, material of Class H 75 is recommended.

CLASS M 73: Brick of this class are intended for use at moderate temperatures such as are encountered in hand-fired boilers operated at average rating not exceeding 125. Resistance to spalling and slagging is important under these conditions of temperature.

CLASS H 25: This class is intended primarily for brick of siliceous nature and for service in which resistance to slagging and spalling is not of particular importance, but in which the refractory is expected to resist deformation under load at relatively high temperatures.

Brick of Class H 25 are particularly adapted for service under conditions where resistance to deformation under load, with soaking heats at relatively high temperatures, is important, but where there is no marked fluctuation of temperature below approximately 650°C (1202°F).

NOTE: Brick of Class H 75 which withstand the load test satisfactorily may be included in this class.

CLASS M 7: This class is intended primarily for brick of siliceous nature, for service at moderate temperatures, and under the conditions where resistance to spalling and slagging is not important, but where resistance to deformation under load is important.

Brick of this class are particularly adapted for service under conditions where resistance to deformation under load, with soaking heats at moderate temperatures, is important, but where there is no marked fluctuation of temperature below approximately 650°C (1202°F).

NOTE: Brick of Class M 1 which withstand the load test satisfactorily may be included in this class.

General Specifications

VIII. No details specified.

SOCIETY OF GLASS TECHNOLOGY

A meeting of the Society of Glass Technology was held in the University, Birmingham, on Wednesday, January 21, the President, Col. S. C. Halse, in the chair. The initial formal business included a resolution to send a cordial invitation, jointly with the (English) Ceramic Society, to the AMERICAN CERAMIC SOCIETY to visit this country in the summer of this year. It was also resolved to invite the Belgian members of the Society of Glass Technology to pay a return visit to this country in May.

The main business of the meeting was a discussion on "The Design of Modern Glass Melting Furnaces." This subject was introduced by two papers, illustrated by lantern slides. The first was: "Some Recent Developments in Furnaces and Gas

Producers for Glass Works" by J. S. Atkinson. The first part of the paper gave information based on more extended experience of the "Stein" recuperative pot furnace. A new design of "Unit" pot furnace was also explained, each unit or section containing two pots. Each section was independently controlled having its own set of recuperator , and gas and air valves, also separate chimney damper. One or two sections could be laid down in the first instance and other sections could be added as required. Turning to tank furnaces, the author described a very interesting design recently installed by T. C. Moorshead at the Charlton Works of Messrs. United Glass Bottle Manufacturers Ltd. The melting tank was shaped somewhat like a torpedo, hence the name "Torpedo" tank. The merits of this furnace were stated to be: (1) By eliminating the corners which the ordinary rectangular furnace had, a more rapid and uniform circulation of the glass was obtained; (2) the construction of the bridge, flared out as it was from the center of the furnace, made it possible to ventilate or cool the side wall and bridge blocks much more efficiently, (3) the effective melting area was not reduced, but the volume of glass in the tank was reduced, giving higher melting efficiency.

Dealing next with continuous leers, Mr. Atkinson described a new design in which very radical changes had been made in the design of the conveyer belt and operating mechanism. The advantages claimed were (1) the high repair cost of the conveyer belts was practically eliminated; (2) stoppages necessitated by repairs to belt and the consequential loss of output were eliminated; (3) alternating current was as suitable as continuous current for the operation of the motor. The first cost of the installation of this new design was about the same as in the case of a leer fitted with Stephens-Adamson type belt.

Referring to gas producers, a description was given of an automatic ash remover which assisted the Chapman agitator working on the top of the fuel bed to maintain a homogeneous fuel bed. A high rate of gasification and a very rich quality of gas resulted. In addition, there were no heavy moving parts, and the ashes were removed continuously. The operation was very simple, and one man could operate from 4 to 6 producers.

The second paper was entitled: "Some Recent Developments in Furnaces and Gas Producers for Glass Works" by Th. Teisen. The author observed that it would be well if glass works would more clearly define their needs and the ideal main lines to be worked on, whether output was to be the deciding factor, or thermal efficiency, life, and so on. In any case the order in which these factors had to be placed must first of all be clearly defined, as that would decide the features of the design. It had to be borne in mind that the use of automatic machinery had called for an increased output which, so long as it was not overdone, would raise the thermal efficiency. Following a discussion of the advantages and defects of the cross flame regenerative glass tank furnace, a comparison of it was made with the open-hearth steel furnace. The author expressed the opinion that in the case of small and medium-sized tanks, a high thermal efficiency might be more easily attained by the use of the recuperative type of furnace, where the width could be relatively small, and the length could be made correspondingly longer, the flame passing toward the working end.

The author exhibited lantern slides showing a proposal for an accessible bridge, which was obtained by giving the tank a wasp shape. Burners might be arranged at the end, and draw-offs on either side of this wasp-shaped bridge. In conclusion, Mr. Teisen proposed the trial of an all steel bridge cooled by water, the molten glass could be made to freeze round it and form a glass bridge. Although there might be some difficulties with the heating up before the glass was founded, he considered that this could be overcome by increasing the amount of cooling water, or it could be protected in other ways. The actual temperature, however, would hardly exceed that of the fire tube in a Cornish boiler.

BUREAU OF STANDARDS NOTES

Investigation of Feldspar and Its Effect in Pottery Bodies

As part of the deta led study of each of the constituent raw materials of a normal whiteware body, the Bureau, in cooperation with the AMERICAN CERAMIC SOCIETY and industrial users of feldspar, is investigating the physical properties of commercial feldspar and its effects in vitreous and semi-vitreous ware.

Feldspar (which is composed of potash, soda, alumina, and silica) acts as a flux at the maturing temperatures of ceramic bodies, and serves to bind the other materials into a common structure. This fluxing behavior, and the other physical characteristics of the feldspar, vary within considerable limits, and a systematic and exhaustive study of their behavior in such bodies is desirable in order that industrial users may have reliable data to guide them in the selection of material possessing the desired qualities.

The investigation is divided into two major parts. The first is in coöperation with several technical institutions, and will involve the determination of softening point, fusion point, screen analysis, and chemical composition. It is proposed to have the work on softening points, air analyses, and chemical analyses conducted by outside technical institutions as well as in the Bureau's laboratories, in order to obtain information on the normal error encountered in determinations of this kind.

The second part of the investigation comprises tests of physical character which are comparable with tests conducted in previous Bureau investigations on ball clay, whiting ($CaCO_3$), and flint (SiO_2). This will include a study of the effect of natural impurities in the feldspar on its viscosity at furnace temperatures, and will involve the following determinations on bodies containing the various feldspars: drying shrinkage; burned color; maturing range; resistance to chipping, impact, and temperature change.

Up to the present time 17 feldspars have been submitted for use in the investigation. Representative samples from each shipment have been submitted to the coöperating institutions and to the Bureau's laboratories for the determination of fusion points and grain fineness. The air analyzer will be used for the latter work. Results from screen analysis and softening point determinations have been received from one coöperating laboratory, and the last-named results check closely to those obtained at the Bureau. It is expected that the results from the major portion of the laboratory work of this investigation will be available in the course of approximately six months. The data so far obtained do not warrant the formation of any conclusions.

Formulas for Determining the Specific Gravity and Index of Refraction of Special Glasses

In connection with the Bureau's work on the composition and physical properties of special glasses, a study of the available data on this subject leads to the conclusion that the specific gravities and indices of refraction of all glasses of the soda-lime-silica series can be computed from the composition of the glasses.

The specific gravity (G) is obtained from the formulas

$$G = g_1 + g_2 + g_3$$
$$g_1 = 0.33\ (x_1 - 30)^{0.45}$$
$$g_2 = 0.02\ (x_2)^{1.08}$$
$$g_3 = 0.03\ (x_3)^{0.98}$$

in which x_1, x_2, and x_3 are the percentages of silica, soda and lime respectively.

The index of refraction (N_d) is obtained from the formula

$$N_d = n_1 + n_2 + n_3$$
$$n_1 = 0.039\ (x_1 - 10)^{0.8}$$
$$n_2 = 0.014\ (x_2)^{1.02}$$
$$n_3 = 0.013\ (x_3 + 1)^{1.07}$$

in which x_1, x_2, and x_3 are the same as above.

It is realized that the constants in these expressions are subject to some change since they are based on the composition of glasses computed from "batch composition" and not on analyzed glasses, and no information is available as to the amount of strain present in the glasses used for determining the specific gravity and index of refraction. However, the computed specific gravity of fine analyzed glasses which contained small amounts of alumina and magnesia, varied less than 0.3% from the observed values, and the computed index of refraction of the same glasses varied less than 0.005 from the measured index.

As a result of this work, the glass manufacturer should be able to determine the composition of his glass very quickly, because tables can be prepared from which it will be possible to determine the composition of a glass from its specific gravity and index of refraction, two determinations which can be made in a relatively short time, instead of by the much longer method of chemical analysis.

Also, the manufacturer of optical glass and optical instruments, to whom the index of refraction is a very important factor, will be able not only to determine what indices may be obtained in this series of glasses, but also to compute with considerable accuracy the composition of the batch required to yield a glass of given index of refraction.

A complete report of this work, which will include references to the data used, method of computation, and an outline of the proposed method of establishing more definite values for the "constants" of the formulas, is being prepared for publication.

Standard Density and Volumetric Tables

The Sixth Edition of Circular No. 19 of the Bureau of Standards, "Standard Density and Volumetric Tables," was issued during January, and copies may be obtained from the Superintendent of Documents, Government Printing Office, at 15 cents apiece.

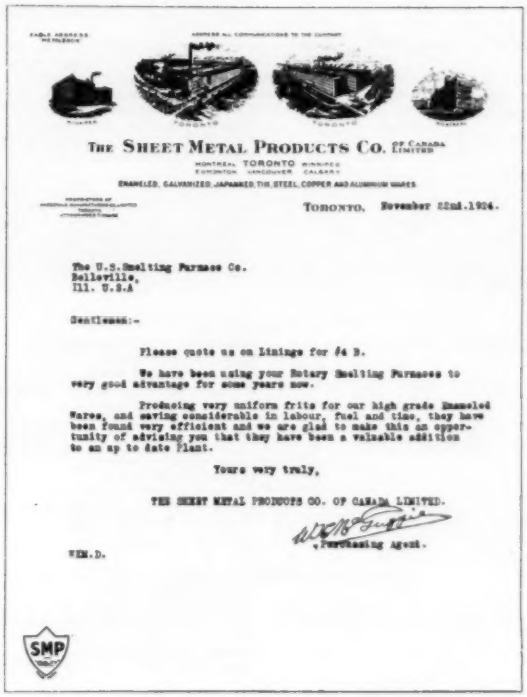
This circular contains standard density tables and others of a similar nature which are most often required in physical and chemical laboratories. The tables given are based on work done by the Bureau and by other investigators. In the latter case due reference is made to the author or to the publication from which the information has been obtained.

Fifty-four tables are included giving information on the density of water from 0 to 102°C; the density of various percentages of ethyl alcohol at various temperatures; the per cent by volume and per cent by weight of ethyl and methyl alcohol solutions of known density; the density and pounds per gallon of milk and cream, and of petroleum oils; temperature corrections to the indications of hydrometers in alcohols, sugar, and sulphuric acid solutions, and petroleum oils; the relation between specific gravity and degrees Baumé for both heavy and light liquids; the relation between specific gravity and degrees A. P. I. for petroleum oils; the capacity of glass vessels as determined by the weight of water contained or delivered at various temperatures; the volume of milk and cream at various temperatures occupied by unit volume at 20°C (68°F); and master scales for the graduation of hydrometers to indicate percentages of ethyl alcohol by weight or by volume, or percentages of proof spirit.

CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	February 8–13, 1926	Atlanta, Ga.
(Summer Meeting)	July 6, 1925	Toronto, Canada
(Fall Meeting)	Oct. 1, 1925	New York City
Am. Assn. of Flint and Lime Glass Mfrs.		
(Annual Meeting)	July, 1925	Atlantic City, N. J.
Am. Electrochemical Soc.	April 23–25, 1925	Niagara Falls, N. Y.
Am. Soc. for Testing Materials	June 22–26	Atlantic City, N. J.
Baltimore-Washington Section		
(American Ceramic Society)	April 4, 1925	Washington, D. C.
Brussels International and Commercial Fair	March 25–April 8	Brussels, Belgium
Chicago Section		
(American Ceramic Society)	March 10, 1925	Chicago, Ill.
Manufacturing Chemists' Association	June, 1925	New York City
Natl. Assn. of Mfrs.	May, 1925	New York City
Natl. Assn. of Mfrs. of Pressed and Blown Glassware	March, 1925	Pittsburgh, Pa.
Natl. Assn. of Stove Mfrs.	May 13–14, 1925	New York City
Natl. Chemical Equipment Assn.	June 22–27, 1925	Providence, R. I.
Natl. Clay Products Industries Assn.	April, 1925	Chicago, Ill.
Natl. Lime Association	May, 1925	
Natl. Exposition of Chem. Industries	Sept. 28–Oct. 3, 1925	New York City

LARGE CANADIAN ENAMELING PLANT USING BATTERY OF U. S. ROTARY ENAMEL SMELTING FURNACES



THE SHEET METAL PRODUCTS CO. OF CANADA LIMITED

MONTREAL TORONTO WINNIPEG
EDMONTON VANCOUVER CALGARY

ENAMELLED, GALVANIZED, JAPANNED TIN, STEEL, COPPER AND ALUMINUM WARES

TORONTO, November 22nd.1924.

The U.S.Smelting Furnace Co.
Belleville,
Ill. U.S.A

Gentlemen:-

Please quote us on Linings for #4 B.

We have been using your Rotary Smelting Furnaces to very good advantage for some years now.

Producing very uniform frits for our high grade Enameled Wares, and saving considerable in labour, fuel and time, they have been found very efficient and we are glad to make this an opportunity of advising you that they have been a valuable addition to an up to date Plant.

Yours very truly,

THE SHEET METAL PRODUCTS CO. OF CANADA LIMITED.

Purchasing Agent.

WEM.D.

SMP

Years of Efficient Service

Very Uniform Frits at a Saving in Fuel, Labor and Time

A Valuable Addition

SIZES AND CAPACITIES

No. 1	No. 2	No. 3	No. 4	No. 4-B
60 lb.	150 lb.	350 lb.	750 lb.	1200 lb.

Description, Photographs, Specifications and Prices Mailed Promptly.

THE U. S. SMELTING FURNACE CO.

BELLEVILLE, ILLINOIS, U. S. A.

A

Air Compressors
General Electric Co.

Alumina (Hydrate and Calcined)
Pennsylvania Salt Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Auger Machines
Chambers Brothers Co.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.

B

Ball Mills
Hardinge Co.
McDanel Refrac. Porcelain Co.
Mueller Machine Co., Inc.

Batts (Alundum-Crystolon)
Norton Co.

Bituminous Coal
Seaboard Fuel Corp.

Blocks (Refractory)
Norton Co.

Boats, Combustion
Norton Co.

Borax
American Trona Corp.
Innis, Speiden & Co.

Boric Acid (Crystal, Granular or Powder)
Innis, Speiden & Co.

Brick Making Machinery
Chambers Brothers Co.

Bricks (Refractory-Alundum-Crystolon)
Norton Co.

Burners (Oil)
Best, W. N. Corp.

C

Carbonates (Barium-Lead)
Innis, Speiden & Co.

Caustic Soda
Pennsylvania Salt Mfg. Co.

Cements
Norton Co.

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Metal & Thermit Corp.
Paper Makers Importing Co., (Inc.)
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Ceramic Engineering Co.
Chambers Brothers Co.
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Clay (Ball)
Johnson-Porter Clay Co.
Paper Makers Importing Co.
United Clay Mines Corp.

Clay (China)
Drakenfeld and Co., B. F.
Edgar Brothers Co.
Paper Makers Importing Co., (Inc.)
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Clay (Electrical—Porcelain)
Edgar Brothers Co.
Johnson-Porter Clay Co.
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

Clay (Enamel)
Edgar Brothers Co.
Johnson-Porter Clay Co.
Paper Makers Importing Co.
Metal & Thermit Corp.
United Clay Mines Corp.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

Clay (Potters)
Johnson-Porter Clay Co.
Paper Makers Importing Co.
United Clay Mines Corp.

Clay (Sagger)
Edgar Brothers Co
Johnson-Porter Clay Co.
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

What do you need?

NEWARK

Trade Mark

We can supply it if it's Wire Cloth.

With our new factory in running order we are now making wire cloth of all metals: Aluminum, Brass, Copper, Bronze, Phosphor Bronze, Nickel, Steel, Monel Metal, Silver, Gold, Platinum, Nichrome and Special Alloys.

Newark Wire Cloth is made in all meshes from .0017 inch space to 4 inch space. .0017 inch space is equivalent to 325 meshes per inch.

We make all widths. All standard widths and most meshes are carried in stock. If you want a special mesh or a special width we can make it.

Of course, we make all lengths.

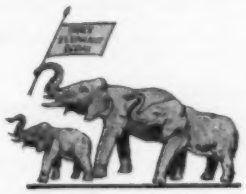
Our new plant on Verona Ave., Newark, N. J.

NEWARK WIRE CLOTH CO.
355–369Verona Ave.
Newark, N. J.

THREE ELEPHANT BORAX
99.5% PURE

Its uniform high quality guarantees the excellence of your product.

Write for our price and samples today.



AMERICAN TRONA CORPORATION

Woolworth Building, **New York, N. Y.**

For Fine Porcelain Enamel

Toncan Metal used as a base for porcelain enameling insures a lasting, brilliant finish, free from blemish. Economical because it reduces waste. Write us for full information.

TONCAN METAL
NATIONALLY ADVERTISED

The United Alloy Steel Corporation, Canton Ohio.

BUYERS' GUIDE (continued)

Clay Handling Machinery
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Clay Miners
Edgar Brothers Co.
Johnson-Porter Clay Co.
Paper Makers Importing Co., (Inc.)
United Clay Mines Corp.

Clay (Wad)
Paper Makers Importing Co., (Inc).

Clay (Wall Tile)
Johnson-Porter Clay Co.
Paper Makers Importing Co., (Inc).
United Clay Mines Corp.

Clay Washing Machinery
Mueller Machine Co., Inc.

Clay Working Machinery
Hadfield-Penfield Steel Co.
Hydraulic Press Mfg. Co.
Mueller Machine Co., Inc.

Cloth (wire)
Newark Wire Cloth Co.

Coal-(Bituminous)—
Seaboard Fuel Corp.

Colors
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

Cones (Filter)
Norton Co.

Conical Mills
Hardinge Co.

Controllers
General Electric Co.

Conveyors (Clay, Sand, Brick, etc.)
Hadfield-Penfield Steel Co.
Philadelphia Drying Machinery Co.
Mueller Machine Co., Inc.

Controllers, (Automatic Temperatures)
Brown Instrument Co.
Engelhard, Charles, Inc.
Wilson-Maeulen Co., Inc.

Cores (Alundum Furnace)
Norton Co.

Cornwall Stone
Pennsylvania Pulverizing Co.

Crucibles (Filter-Melting-Ignition)
Norton Co.

Crushers
American Pulverizer Co.
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Crushers (Ring)
American Pulverizer Co.

D

Decorating Supplies
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Discs (Alundum-Porous-Filter)
Norton Co.

Dishes (Alundum-Filtering-Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Dolomite
Innis, Speiden & Co.

Dryers (China Ware—Porcelain)
Ceramic Engineering Co.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Drying Machinery
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

E

Electrical Instruments
Brown Instrument Co.
Engelhard, Charles, Inc.

Electric Co; Meters
Brown Instrument Co.

Electrical Porcelain Machinery
Mueller Machine Co., Inc.

Enameling Equipment, Complete
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.

Special for Glassmakers and Potters

GREEN
OXIDE OF CHROME

in variety of shades

Guaranteed to contain no Free Sulphur
nor Sulphides

B. F. DRAKENFELD & CO., INC.
50 Murray Street, New York

Enameling Furnaces
Chicago Vitreous Enamel Product Co.
Combustion Utilities Corp.
Ferro Enamel Supply Co.
General Electric Co.
Holcroft & Co.
Surface Combustion Co.
The Carborundum Co.
(*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
U. S. Smelting Furnace Co.
Vitro Mfg. Co.

Enameling Furnaces (Electric)
General Electric Co.

Enameling Muffles
General Electric Co.
Parker-Russell Mining & Mfg. Co.
The Carborundum Co.
(*Carbofrax*)

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Engineering Service
Ceramic Engineering Co.
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Tefft, C. Forrest

Equipment (Electrical)
General Electric Co.

Equipment (Porcelain Enameling)
The Porcelain Enamel & Mfg. Co.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

F

Feldspar
Cummings, J. W.
Drakenfeld and Co., B. F.
Eureka Flint & Spar Co.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co. (*Isco*)
Maine Feldspar Co.
Pennsylvania Pulverizing Co.
Roessler & Hasslacher Chemical Co.

Filtering Machinery
Mueller Machine Co., Inc.

Fire Brick
Parker-Russell Mining & Mfg. Co.
The Carborundum Co.

Flint
Eureka Flint & Spar Co.
Innis, Speiden & Co. (*Carrara*)
National Silica Co.
Pennsylvania Pulverizing Co.

Fuel
Seaboard Fuel Corp.

Furnaces
Chicago Vitreous Enamel Product Co.
Combustion Utilities Corp.
Ferro Enamel Supply Co.
Holcroft & Co.
Parker-Russell Mining & Mfg. Co.
The Carborundum Co. (*Carboradiant*)
The Porcelain Enamel & Mfg. Co.
The Surface Combustion Co.
U. S. Smelting Furnace Co.

Furnaces (Electrical)
General Electric Co.
Holcroft & Co.

G

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Gold
Drakenfeld, and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

H

Hearths
The Carborundum Co.
(Carbofrax heat treating)

I

Impervite (Refractory and Hard Porcelain)
Engelhard, Charles, Inc.

Infusorial Earth
Innis, Speiden & Co.

Iron (Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

The ARMCO Label a Selling Help

Are you one of the hundreds of manufacturers that are taking advantage of ARMCO'S large investment in advertising by using the blue and gold ARMCO label on your product?

Our Saturday Evening Post advertising is causing more and more people to look for this label when they are buying products made wholly or partly of ARMCO-Ingot Iron.

For more than 16 years ARMCO-Ingot Iron has been "the purest iron made." Experience has taught many people that Ingot Iron adds quality to a product and that it is good business to buy products made of Ingot Iron.

Another great value in the label to the manufacturer and retail merchant is the association of products. A gas range sells a refrigerator, a table top or some other article. Ingot Iron is used in all of these and in many others. The ARMCO label will identify *"the purest iron made"* in your product.

THE AMERICAN ROLLING MILL CO., Middletown, Ohio

(Export)

The ARMCO International Corporation
Cable Address—ARMCO, Middletown

THE AMERICAN ROLLING MILL CO., Middletown, Ohio

Please send me.....blue and gold labels

NAME.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....

We manufacture.....of ARMCO-Ingot Iron.

(The J. of The A. C. Society—3-1-25)

BUYERS' GUIDE (continued)

J

Jiggers
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

K

Kaolin
Edgar Plastic Kaolin Co.
Harshaw, Fuller and Goodwin Co.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Kilns
Holcroft & Co.

Kryolith
Pennsylvania Salt Mfg. Co.

L

Linings (Furnace-Refractory Block-Refractory Plate, Brick and Tile)
Norton Co.
The Carborundum Co.

M

Magnesite
Innis, Speiden & Co.

Manganese
Hy-Grade Manganese Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.
The Mansfield Sheet & Tin Plate Co.
United Alloy Steel Corp.

Mills (*See under Ball Mills*)
(*See under Pebble Mills*)

Minerals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Mixing Machines
Chambers Brothers Co.

Muffles (Furnace)
Norton Co.
The Carborundum Co. (*Carbofrax*)

Muriatic Acid
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

N

Nitrates (Cobalt, Sodium)
Innis, Speiden & Co.

O

Oil Burners
Best, W. N. Corp.

Opacifiers
Titanium Alloy Mfg. Co.

Operators (Coal)
Seaboard Fuel Corp.

Oxides
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Paper Makers Importing Co., (Inc.)
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg Co.

P

Pans (Wet and Dry)
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Pebble Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Placing Sand
Pennsylvania Pulverizing Co.
National Silica Co.

Plate Feeders
Chambers Brothers Co.
Hadfield-Penfield Steel Co.

Plates (Filter)
Norton Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
The Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Potash (Carbonate)
Innis, Speiden & Co.

Pottery Machinery
Hadfield-Penfield Steel Co.
Hydraulic Press Mfg. Co.
Mueller Machine Co., Inc.

In Vitreous Enameling

Opacity can be obtained more economically and satisfactorily with

OPAX

than with any other opaquing material.

OPAX does not contain antimony, arsenic, lead, or tin. It is non-poisonous. Unlike expensive tin oxide, is not affected by fluctuations in price of foreign controlled tin.

OPAX is being manufactured under careful chemical control, therefore, its composition will remain constant.

Analysis of OPAX will be furnished upon request. You are entitled to know the composition of materials you are purchasing and should insist on having this information to assure yourself that the composition of your materials is not changed from time to time.

THE TITANIUM ALLOY MFG. CO.

NIAGARA FALLS, N. Y.

New York Office:	Pittsburgh Office:	Chicago Office:
94 Fulton St.	Oliver Bldg.	Peoples Gas Bldg.

OPAX

BUYERS' GUIDE (Continued)

Pug Mills
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.

Pulverizing Machinery
American Pulverizer Co.
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pulverizing Mills
Hadfield-Penfield Steel Co.
Hardinge Co.
Mueller Machine Co., Inc.

Pulverizers (Ring)
American Pulverizer Co.

Pumps
Mueller Machine Co., Inc.

Pyrometers (Indicating)
Brown Instrument Co.
Engelhard, Charles, Inc.

Pyrometers (Recording)
Brown Instrument Co.
Engelhard, Charles, Inc.

Pyrometer (Switches)
Brown Instrument Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Engelhard, Charles, Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

R

Recording Instruments
Brown Instrument Co.
Engelhard, Charles, Inc.

Recuperators
The Surface Combustion Co.

Refractories
Massillon Refractories Co.
Norton Co.
The Carborundum Co.

Refractory Materials
Massillon Refractories Co.
Parker-Russell Mining & Mfg. Co.

Regulators (Automatic Temperatures)
Brown Instrument Co.
Engelhard, Charles, Inc.

S

Saggers
Norton Company
The Carborundum Co.

Sagger Presses
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Mueller Machine Co., Inc.
Watson-Stillman Co.

Screens
Newark Wire Cloth Co.

Selenite of Sodium
Drakenfeld and Co., B. F.
Vitro Mfg. Co.

Shippers (Coal)
Seaboard Fuel Corp.

Silica Brick
Parker-Russell Mining & Mfg. Co.

Silex Lining
Hardinge Co.

Sillimanite (Synthetic)
Norton Co.

Slabs (Furnace)
Norton Co.

Smelters
Ferro Enamel Supply Co.
Parker-Russell Mining & Mfg. Co.
The Surface Combustion Co.
U. S. Smelting Furnace Co.

Soda Ash
Innis, Speiden & Co.

Sodium Antimonate
Metal & Thermit Corporation
Vitro Mfg. Co.

Sodium Fluoride
Innis, Speiden & Co.

Spar
Eureka Flint and Spar Co.
Maine Feldspar Co.
Pennsylvania Pulverizing Co.

Sulphuric Acid
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

"HURRICANE" Ceramic Dryers

PRACTICAL EXPERIENCE has taught us to handle *YOUR* particular drying problem efficiently.

The *"HURRICANE"* dries quickly and thoroughly, with unbelievable reduction in cost.

LET US furnish accurate, specific information about "Hurricane" Ceramic Dryers.

MAY our Engineering Department help you?

THE PHILADELPHIA DRYING MACHINERY COMPANY

Ceramic Drying Machinery

Canadian Agents:
Whitehead, Emmans, Ltd.
Montreal

HURRICANE
Ideal Drying Every Day

Stokley Street above Westmoreland, Philadelphia, Pa.

New England Agency:
Hurricane Engineering Co.
53 State St., Boston, Mass.

WABIK METAL QUALITY M PRODUCTS

After an exhaustive study of the requirements of the Enameling Industry we are producing:

WABIK METAL SPECIAL VITREOUS ENAMELING SHEETS

Unlike ordinary steel sheets, warping and blistering is reduced to a minimum, thus increasing the Enameler's output and profit.

Many of the leading plants now recognize "WABIK METAL" as the supreme stock for that beautiful permanent lustre which is so essential in Table Tops, Stove Parts, Refrigerator Parts, Signs, etc.

THE MANSFIELD SHEET & TIN PLATE CO.
MANSFIELD, OHIO

T

Tachometers
Brown Instrument Co.

Talc
Innis, Speiden & Co.

Temperature Instruments (Measuring)
Brown Instrument Co.
Engelhard Charles, Inc.

Thermocouples
Brown Instrument Co.

Thermometers (Electric Resistance)
Brown Instrument Co.
Engelhard Charles, Inc.

Thimbles (Filtering Extraction)
Norton Co.

Tile Machinery (Floor and Wall)
Mueller Machine Co., Inc.

Titanium
Titanium Alloy Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tubes (Pyrometer)
Brown Instrument Co.
Engelhard Charles, Inc.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

V

Vacuum Pumps
Mueller Machine Co., Inc.

W

Wet Enamel
The Porcelain Enamel & Mfg. Co.
Ferro Enamel Supply Co.
Vitro Mfg. Co.

Whiting
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Witherite
Innis, Speiden & Co.

Z

Zirconia
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

ENGLISH AND DOMESTIC

QUALITY

POTTING

CLAYS

Paper Makers Importing Co., Inc.
EASTON PENNA.

(When writing to advertisers, please mention the JOURNAL)

Lasting Linings for Enameling and Pottery Muffles, Ovens, Furnaces, and Kilns

Regarding the bisket muffle kiln, we are glad to report that the Alundum tile are far exceeding any hopes which we had for any tile used in a muffle kiln. The kiln has fired 24 times since it was repaired and not only do the tile show no signs of wear, but there is not even a cracked mortar joint in the muffle.

The above paragraph is from a letter received by us from a large manufacturer of porcelain ware. It tells a true story and we know of no reason why it will not be true years from now.

"Alundum" is Norton Company's trademark for bonded fused alumina and it should have careful consideration because of its stability, strength, inertness, long life, heat conductivity and refractoriness. Well known furnace engineers recognize and specify this material.

Effect economies by using Alundum Refractories for enameling and pottery muffles, ovens, kilns and furnaces.

Write for our booklet "Norton Refractories for Heavy Duty" and include in your letter details of your refractory problems. We want to assist you.

NORTON COMPANY
Worcester, Mass.

R–221a

TRADE NORTON MARK

(When writing to advertisers, please mention the JOURNAL)

ALPHABETICAL LIST OF ADVERTISERS

	Page
American Pulverizer Co.	31
American Rolling Mill Co.	11
American Trona Corp.	7
Best, W. N. Corp.	32
Brown Instrument Co.	20
Carborundum Co.	33
Central of Georgia Railway	1
Chambers Brothers Co.	29
Drakenfeld and Co., B. F., Inc.	9
Edgar Plastic Kaolin Co.	30
Engelhard, Charles, Inc.	29
Eureka Flint & Spar Co.	3
Ferro Enamel Supply Co.	23
Hadfield-Penfield Steel Co.	34
Harshaw, Fuller and Goodwin Co.	2
Holcroft & Co.	23
Hy-Grade Maganese Co., Inc.	23
Innis, Speiden & Co., Inc.	26
Johnson-Porter Clay Co.	26
Journal of the Society of Glass Technology	21
Maine Feldspar Co.	25
Mansfield Sheet & Tin Plate Co.	15
McDanel Refractory Porcelain Co.	23
Metal & Thermit Corp.	Outside Back Cover
Montgomery Porcelain Products Co.	24
Mueller Machine Co., (Inc.)	32
National Silica Co.	34
Newark Wire Cloth Co.	7
Norton Co.	18
Paper Makers Importing Co., (Inc.)	17
Parker-Russell Co.	23
Pennsylvania Pulverizing Co.	26
Pennsylvania Salt Mfg. Co.	24
Perham, A. C.	31
Philadelphia Drying Machinery Co.	15
Porcelain Enamel & Mfg. Co.	Inside Back Cover
Proctor and Schwartz, Inc.	4
Professional Directory	28
Roessler and Hasslacher Chemical Co.	Inside Front Cover
Seaboard Fuel Corporation	22
Surface Combustion Co.	27
Titanium Alloy Mfg. Co.	13
United Alloy Steel Corpn.	7
United Clay Mines Corp	23
U. S. Smelting Furnace Co.	5
Vitro Manufacturing Co.	25
Watson-Stillman Co.	24

What did you learn about Brown Pyrometers at Washington, Chicago, or Columbus?

Did you talk over Pyrometers?

If you did—considering the number of veteran Brown users attending conventions, we know that you are convinced that you should install Brown Pyrometers.

Then, let's get started. Just tell us the number and type of your Kilns, the fuel used, ware burned and we will outline an equipment which will give you results equal to the best the other fellows were telling you about.

Let's get started—at once.

Address — The Brown Instrument Company, 4505 Wayne Avenue, Philadelphia, Pa., or one of our District Offices, at New York, Boston, Pittsburgh, Detroit, Chicago, Birmingham, Houston, Tulsa, St. Louis, Denver, Salt Lake City, San Francisco, Los Angeles, or Montreal.

Brown Pyrometers

Most used in the world

CLASSIFIED ADVERTISING

Professional Services

Excellent opportunity for an experienced cast iron enameler, wet and dry processes. Applicant must be capable of conducting cast iron department in its entirety. Address "Belmaco, American Ceramic Society, Lord Hall, O. S. U., Columbus, Ohio."

NEW CLASSIFIED RATES EFFECTIVE MARCH 1st

15c per word exclusive of address.

No advertisement less than 50 Words.

WANTED: All around, high grade terra cotta man, factory experience essential, familiarity with architects very desirable, technical training preferred. Proposition is new. Future in man's own hands. Address "Opportunity," American Ceramic Society, Lord Hall, O. S. U., Columbus, Ohio.

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

ANNUAL SUBSCRIPTIONS TO SOCIETY (Including Journal)

Ordinary Members	$ 7.00
Collective Members	$15.00
Price per Number to non-Members	$ 2.50
Price per volume (unbound) to non-Members	$ 9.00

Forms of application for membership may be obtained from the American Treasurer of the Society, Mr. Wm. M. Clark, Ph.B., Nela Park, Cleveland, Ohio.

Address orders and inquiries to: The Secretary, Society of Glass Technology, The University, Sheffield, England.

COAL FACTS

"ELIMINATE WASTE
and
REDUCE PRODUCTION
COSTS"

by firing your Kilns with COAL OF KNOWN VALUE. The particular requirements of the Ceramic and Clay Products Industries, demand a coal which is—

LOW in Ash, Sulphur and Volatile, of High Fusing Point and Non-Clinkering.

Many users have found—
SEABOARD COALS
to be of a definitely known value.

260
South Broad St.
Philadelphia

SEABOARD FUEL CORPORATION

No. 1
Broadway
New York City

THE PARKER RUSSELL CO.
ST. LOUIS

BUILDERS OF
RO-MACK Enameling Furnaces
HIGH TEMPERATURE FURNACES
For all Purposes

HIGH GRADE REFRACTORIES

TRADE MARK
Pyrometer Tubes—Protection Tubes—Combustion Tubes
McDanel Refractory Porcelain Company
Beaver Falls, Pennsylvania

UNUSUAL · SHAPES · OUR · SPECIALTY ·

HIGH GRADE
CLAYS
OF EVERY KIND—FOR EVERY PURPOSE
UNITED CLAY MINES CORPORATION TRENTON, N J.

Continuous Tunnel Kilns
Vitreous Enameling Furnaces
HOLCROFT & CO.
6545 Epworth Blvd., Detroit, Mich.

SEND FOR THE BLUE PRINT
Describing our new BOBLOY Pointed Loop Racks, Plain Loops, Point Bars, Tee Bars. The finest metal marketed at its price.
THE FERRO ENAMEL SUPPLY CO. CLEVELAND, O.

USE "HY-GRADE" MANGANESE
for surface and body coloring. We pay special attention to our 200 mesh powder that will not "Cat Eye" in glazes.

We mine and very carefully prepare every pound of our own product.

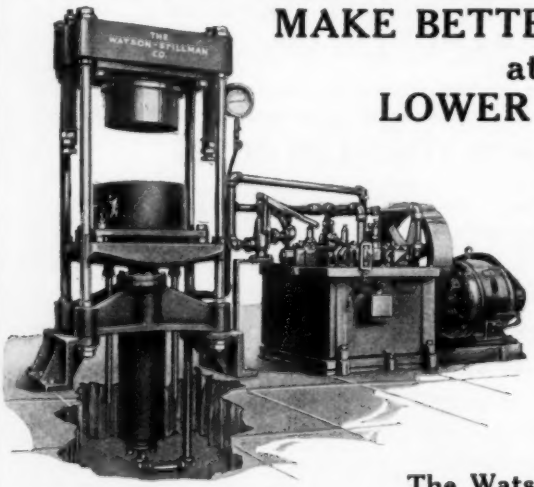
HY-GRADE MANGANESE COMPANY, Inc.
WOODSTOCK, VIRGINIA.

(When writing to advertisers, please mention the JOURNAL)

If you want pyrometer protection tube satisfaction
USE
Montgomery Hard Porcelain Pyrometer Tubes
All Sizes and Lengths for either Platinum or Base Metal Couples
The Best Liked and Most Largely Used
Protection Tubes on the Market today
If the manufacturer of your pyrometer equipment cannot supply you, write us direct.
TRADE MARK
MONTGOMERY PORCELAIN PRODUCTS CO.
FRANKLIN, OHIO, U. S. A. 10-22

HEAVY CHEMICALS
for the
CERAMIC AND GLASS INDUSTRIES
Sole Importers of
GREENLAND KRYOLITH
PENNSYLVANIA SALT MANUFACTURING COMPANY
Executive Offices: Philadelphia, Pa.
Works: Philadelphia and Natrona, Pa. Wyandotte and Menominee, Mich.
Representatives: New York Chicago Pittsburgh St. Louis

WATSON-STILLMAN SAGGER PRESSES
MAKE BETTER SAGGERS
at
LOWER COST



Showing a 50 Ton Sagger Press Outfit Complete equipped with dies for making Elliptical Sagger.

These Machines press saggers from solid wads of clay. Our sagger dies have no joints to work loose or open under pressure, this insures a homogeneous product and reduces to a minimum the losses in firing.

Write for Bulletins and full information

The Watson-Stillman Co.
28 DEY STREET, NEW YORK
Chicago, McCormick Building
Philadelphia, Widener Bldg.

Metallic Oxides
Prepared Oxides

Uniform

THE VITRO MFG. CO. TRADE MARK PITTSBURG, PA.

Intense

Write For
New Color Card and Prices

VITRO MANUFACTURING CO.
PITTSBURGH, PA.

MAINE FELDSPAR COMPANY
Grinders of
Mt. Apatite Spar

Mills
Auburn and Topsham, Maine

Main Office
Brunswick, Maine

Sales Agents
Charles M. Fransheim Co., Wheeling, W. Va.

THE
JOHNSON-PORTER
CLAY COMPANY
McKENZIE, TENNESSEE.

Producers of High Grade Clays for all Branches of the White Wares Industry.

Purchase your Ball, Sagger and Wad Clays direct from the producer, and thus know who is responsible for their quality.

1816 CHEMICALS 1925

"Over a Century of Service and Progress"

South Dakota
FELDSPAR

An extremely high-grade Potash Spar ground in our own mills under constant and thorough chemical control.

Capacity up to 300 Tons Daily

We solicit your inquiries

INNIS, SPEIDEN & CO., Inc.
Importers, Manufacturers, Exporters
46 CLIFF STREET NEW YORK

Branches:
BOSTON PHILADELPHIA CHICAGO
CLEVELAND GLOVERSVILLE

PENNSYLVANIA PULVERIZING CO.
LEWISTOWN, PENNA.

Pure Canadian Potash Feldspar

Potters Flint Placing Sand

SALES OFFICE
323 Fourth Avenue
Pittsburgh, Pa.

8 classes of service

Fuel Surveys

Using trained combustion survey engineers, we come into your plant, make a complete history of every industrial heating operation, all fuel and handling costs, and submit you the results in portfolio form, together with our recommendations

2. Plant Layout
3. Complete Standardized Furnaces
4. Complete Furnace Designs
5. Converting Existing Furnaces
6. Developing Specialized Furnaces
7. Stock Furnaces
8. Auxiliary Equipment.

Doctors of Industry

There is a family of men who are devoting their lives to the advancement of industrial heating methods—

These "Doctors of Industry" call upon factory superintendents—just as the family doctor calls upon his patients—

When advisable, a diagnosis of all heating operations is made, and if possible, improvements are suggested—

These "Doctors of Industry" serve large and small manufacturers with equally good care—they chat with the little brass smelter as well as the large steel operator—

In the past few years, they have participated in more than ten thousand industrial installations—

These "Doctors of Industry" are the personnel of the Fuel Survey Service of the Surface Combustion Company—the largest organization of its kind in the world.

Utilization Division of the Combustion Utilities Corporation

THE SURFACE COMBUSTION CO.

372 Gerard Ave., Bronx, N. Y.

Branch Offices:

Hartford	Boston	Philadelphia
Toronto	Baltimore	St. Louis
Pittsburgh	Buffalo	Seattle
Detroit	Chicago	Birmingham

PROFESSIONAL DIRECTORY

A CONSULTING SERVICE
that will actually help you develop profits is available.

"Nothing to Sell but Engineering Service

C. FORREST TEFFT
Graduate Ceramic Engineer, Watsontown, Pa.

LOUIS G. ROBINSON LABORATORIES
Consulting Ceramists
for the
Enamel and Silicate Industry
Chemical Analyses
Raw Materials and Products
31 E. Fourth St. Cincinnati, O.

THE SHARP-SCHURTZ COMPANY
Chemists for the Ceramic Industry
We have fully equipped laboratories at
Lancaster, Ohio, U. S. A.

THIS SPACE IS ONLY
$30
PER YEAR

AMERICAN CERAMIC SOCIETY
LORD HALL, O. S. U.,
COLUMBUS, OHIO

CERAMIC BREVITIES

Mr. John Maddock grandson of John Maddock of the John Maddock & Sons Pottery Co., Trenton, N. J., has recently become affiliated with the Paper Makers Importing Co., Easton, Pa. Mr. Maddock is a graduate of Rutgers College, New Brunswick, N. J. and under his supervision The Paper Makers Importing Co., can assure the trade of uniform, dependable clays for all purposes.

ENGELHARD PYROMETERS
for
—TUNNEL KILNS—

Engelhard Pyrometers have many exclusive features that make them desirable for tunnel kilns, and they have been applied to almost every type of tunnel kiln.

A notable installation is on the Dressler Kiln at the Ford Motor Co's glass plant at Glassmere, Pa., which is used for pot heating for plate glass manufacture.

CHARLES ENGELHARD, INC.
30 CHURCH STREET
NEW YORK-U·S·A·

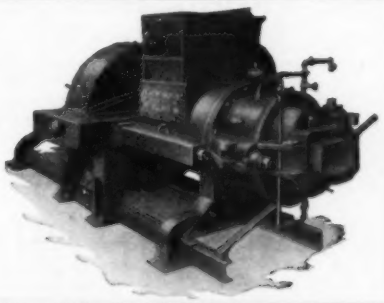
The Directory is being enlarged to meet a demand determined after a careful survey of the needs of the industry. If you have not sent in your listings, do so at once—accompany these listings with your page advertisement to secure the business you want.

Advertising Dep't.
AMERICAN CERAMIC SOCIETY
Lord Hall, O. S. U. Columbus, Ohio

Brick Making Machines

Crushers Grinders Mixers
Automatic Cutters

Chambers Bros. Co.
Philadelphia Pa.



(When writing to advertisers, please mention the JOURNAL)

"EDGAR CLAYS"

Florida—Georgia—New Jersey

Home Office
METUCHEN, N. J.

OUR AIM

To Have

Clay Preparation unsurpassed

Service prompt and complete

Reserve stock of clay ample

Sales effort to include dependable advice

Shoot an inquiry and test our AIM

PRODUCTION UNDER MANAGEMENT

of

THE EDGAR PLASTIC KAOLIN COMPANY

LAKE COUNTY CLAY COMPANY

EDGAR BROTHERS COMPANY

(When writing to advertisers, please mention the JOURNAL)

Paris Crystal Spar

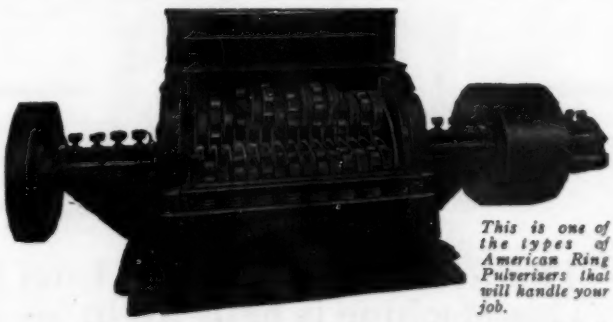
Designates

Pure Crystal Spar

No Free Quartz

No Impurities

A. C. PERHAM **West Paris—Maine**



This is one of the types of American Ring Pulverisers that will handle your job.

When You Buy—*Consider It!*

When you are in the market for pulverizing equipment, include the American Ring Pulverizer in your investigations.

See how the ring method of crushing brings lower operating cost and an elimination of costly shut-downs.

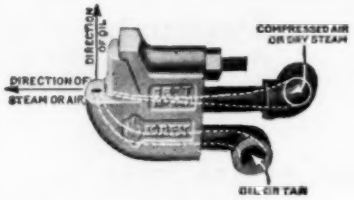
We assure you that it does an unapproachable job on grog, glass cullets, coal and clay: but don't be convinced by our statement. Ask for the actual facts and figures based on the performance for scores of successful companies.

AMERICAN PULVERIZER CO.

18th and Austin Sts., St. Louis, U. S. A.

AMERICAN Ring PULVERIZERS

W. N. BEST Oil Burners

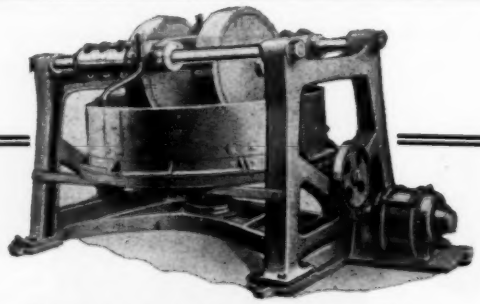


A superior burner backed by thirty-four years of successful practical application in every industrial field. *—If heat distribution is desired consult our engineers.*

Catalogs upon request

W. N. BEST Corporation

11 BROADWAY NEW YORK



"—There is no getting away from it, This Machine is built Right"—

The superior qualities of a

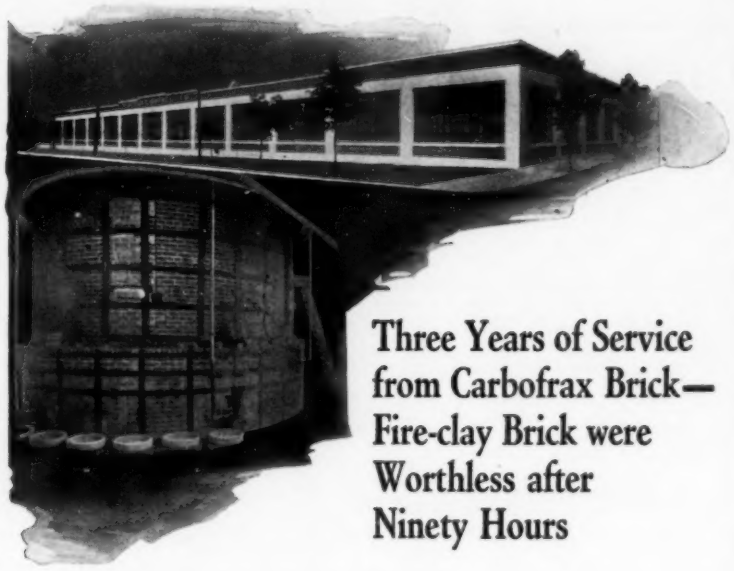
MUELLER GROG PAN

are not to be found by simply looking at it—actual operation will prove to you immediately that this is the machine for your grinding problem—It does the job right.

Let us tell you where* Mueller Machines *are saving money.

THE MUELLER MACHINE CO.

TRENTON, NEW JERSEY



Three Years of Service from Carbofrax Brick—Fire-clay Brick were Worthless after Ninety Hours

THE Mitchell-Bissell Company of Trenton, N. J. make porcelain thread guides for textile machinery—tiny, intricate bits of ware that are vitrified in high temperature oil-burning kilns. One of their problems was in keeping fire brick in the combustion chambers.

The best grade of fire-clay brick lasted but two heats of from forty-two to forty-five hours each.

In eight months they spent $2,000 in repairs and replacements. Then, three years ago, they installed Carbofrax Brick for linings and piers.

Today those brick are still in service. They have stood up under a temperature of 3,000 degrees fahrenheit without softening. They have withstood quick temperature changes without cracking. They have shown little or no effect from flame erosion.

Once again is proved the worth of Carbofrax—the Carborundum refractory.

Carborundum Refractories

Brick and Tile for Boiler and Furnace Settings; Muffles for Enameling Furnaces; Hearths for Heat-Treating Furnaces; Cements for all High Temperature Work

The Carborundum Co., Perth Amboy, N. J.

Williams & Wilson, Ltd., Montreal
Pacific Abrasive Supply Company, San Francisco, Los Angeles

THE CERAMIC INDUSTRY'S BEST ASSET

BUILT RIGHT
RUN RIGHT
FOR CLAY WORKERS

The best Asset of the Ceramic Industry is quality of product and quality of product is largely dependent on properly prepared Materials. The American Wet Grinding Pan does its work thoroughly, quickly and cheaply. This is an unusually well built, dependable unit. Long on service. Light on power. Ask for Bulletin.

We build a complete line of machinery for Ceramic needs.

The Hadfield-Penfield Steel Co.
BUCYRUS, OHIO

The National Silica Co.

OREGON, ILL.

Producers and Pulverizers of

FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica ***140 Silk Lawn Test***

Get This Free Book!

Authoritative Information

"Successful Enameling via the Pemco Plan" contains authoritative data, the result of 25 years experience as the makers and appliers of the most successful porcelain enamels in America.

Gives the key to the results obtained by more than sixty of the most successful enameling plants in the United States, Canada and Australia.

Describes methods of operation, how to overcome certain troubles, shows plant layout, lists successful equipment and its cost, shows operation costs, a comparison with the current market, and other pertinent facts.

Mail the coupon below, or write us —a copy will be sent you cheerfully, without obligation or cost.

Pemco Service Assures Success

PEMCO

THE PORCELAIN ENAMEL & MFG. CO.

BALTIMORE . . . MARYLAND

PEMCO, Baltimore, Md.

Please send without cost or obligation, a copy of the booklet "Successful Enameling via the Pemco Plan."

Name_____

Address_____

M & T
TIN OXIDE

is preferred by foremost firms throughout the country, making terra cotta, faience, tiles, sanitary pottery and art pottery.

A uniform product, free from impurities, and with unexcelled covering power.

We welcome inquiries, and will gladly send samples for test purposes.

Exclusive Agents for

Johnson-Porter Enamel Clays

By giving exceptionally good results in floating enamel these clays are rapidly supplanting foreign enamel clays.

METAL & THERMIT CORPORATION

Ceramic Department
Homer F. Staley, Mgr.

120 Broadway
New York